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The

Principles, Methods, and Costs of Operation West of the Cascades in Oregon and Washington, with Respect to Timber Appraisals.

Part 2

by

W. H. Gibbons, Forest Examiner.

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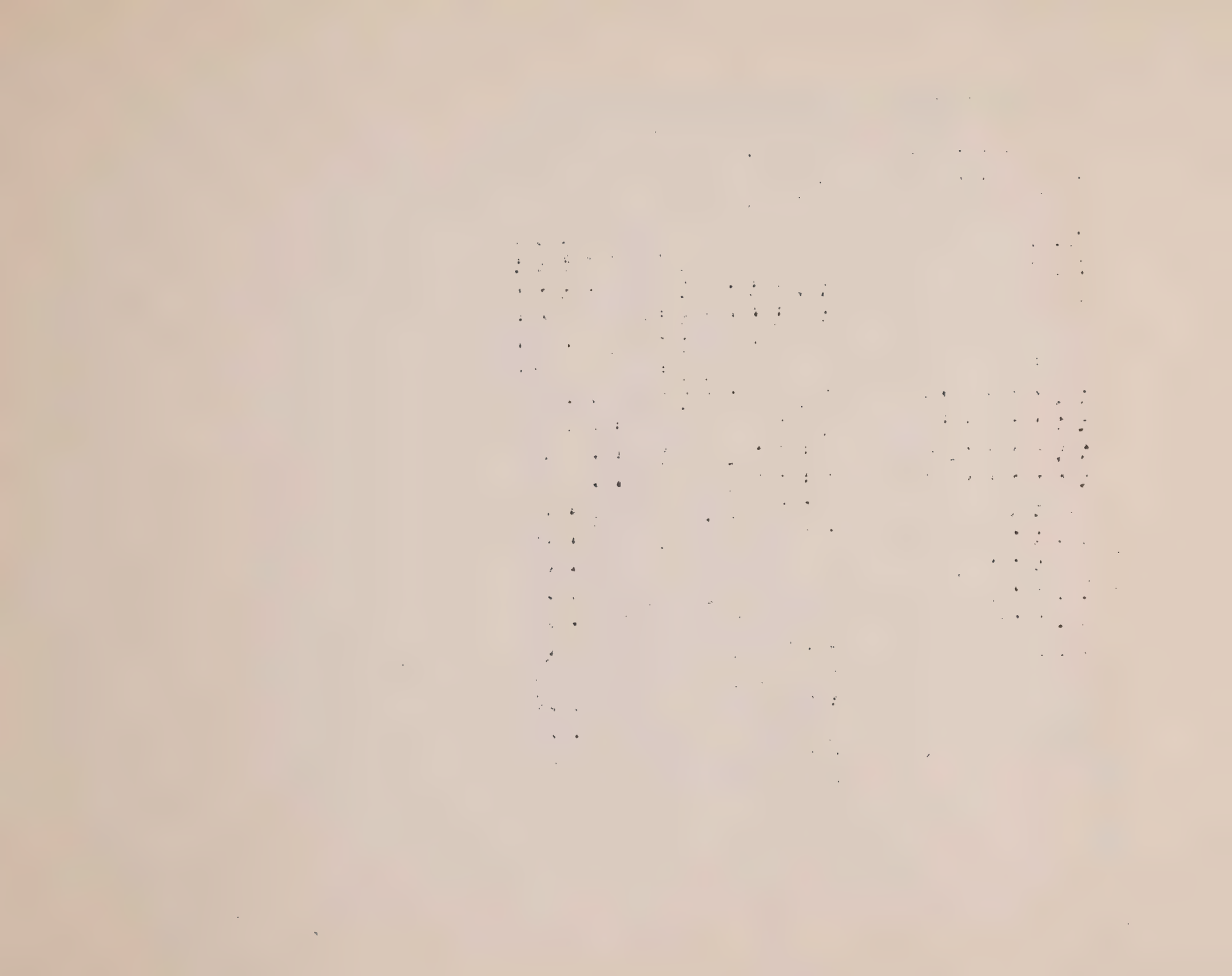

PART II

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FELLING AND BUCKING

Officers in Charge of Service Sales Should Have a Knowledge of Felling and Bucking.

The Forest Service in its propaganda work and in selling National Forest timber stands for the closest utilization compatible with good economy. One way which has long been recognized, is to get the logging companies to exercise the proper amount of care in felling and bucking their timber. Not infrequently the old cuttings of companies working under seemingly the same conditions exhibit varying degrees of care in this step of the logging operations. One will show "no excessive loss from breakage, while another will be found with 10 to 15 M feet that could have been saved." One authority in discussing this work made the following statement:

"Next to forest fires, careless felling is the cause of the wasting of much valuable timber. It would only be stating plain facts to say that two-thirds of all the waste caused through breakage in felling is due to carelessness.

"It is strange that timber owners and men in charge of logging camps pay no more attention to this particular part of their business. Some, to be sure, insist on having their stumps cut low, and that may save a few inches or feet of timber, but that is, as a rule, as far as they go. There is a big difference between a foot or two saved at the butt, and fifty feet or more broken into kindling farther up.

"It is a fact that the average faller of good sized timber, who averages say fifty thousand a day, can easily save five thousand or more feet a day by being a little more careful.

"One reason this slaughter of timber is permitted is that the man in charge of the falling crews, generally the foreman of the camp, is rarely ever an experienced faller. Another reason is green men. Every tree represents a problem of its own, which to solve successfully takes years of practical experience. If you were the owner of, say a section of timber, and a fire ran through it and destroyed it, you would think yourself a ruined man. Yet this is actually what happens. One-third of all the timber that is felled, take it straight through, good and bad ground, is destroyed by breakage; and, as before stated, two-thirds of this enormous waste is due to ignorance or carelessness.

"A few suggestions--well known as they ought to be, but more or less sadly neglected--to prevent this big loss of timber and energy: Have an experienced man in charge of your falling crews. Have all the windfalls bucked ahead of the felling. When cutting short logs where the timber is thick, make two or three fellings; that is, fell part of it, have it bucked, then fell the rest. Never let your fallers cross one tree over another before the lower one is bucked, for one or the other, often both, will break. By strictly observing these rules, you will save more of your timber, and your rigging crew

will have logs and not broken chunks to pull. Much, however, will depend on individual judgment and effort."

If it often necessary to break timber in felling it, even though all possible care is taken. Then, again, it may happen that the gain through reduced breakage will be more than offset by the cost of the care exercised. Generally speaking, there is a relation between the loss through breakage and the value of the stumpage; loss through breakage should decrease as stumpage increases in value. This suggests that the method used must be considered in connection with cost and return. It would be poor management to save wood at the expense of labor and capital.

If it is true that logging companies who have purchased their timber outright not infrequently lose money through careless felling and bucking, it would seem that the Forest Service in basing the selling price of a block of timber on the amount logged and scaled is justified in taking the position that purchasers of National Forest timber shall exercise reasonable care in the felling and bucking of the timber.

Forest Service timber sale contracts deal in a general way with the question of felling and bucking, and on some features of the work state specifically what shall or shall not be done. It has not been deemed practical to treat all phases of the subject in a definite manner, and this has resulted in much discretionary power being given to the Forest officers in charge of sales. Where the contract is not specific the as-

sumption no doubt is that the purchaser will do the work in accordance with the practice of progressive operators under like conditions. This means that these officers should have a knowledge of felling and bucking methods, also of the cost of this step of the operation.

Care Necessary in Collecting Cost Data Dealing with Felling and Bucking.

In collecting cost data dealing with felling and bucking, care should be exercised to determine what the statements include. The statements may include only the labor cost, or they may include the labor, equipment, and supply costs. Then, again, the character of the labor included should be determined. In addition the amount of sound materials secured from windfalls, if possible, should be obtained; also the amount of defect in the standing timber. When these factors cannot be obtained a mental note of the fact should be made. Of course, where the data is included in a written cost statement, the fact will be noted. The point may be illustrated by taking a case in connection with bucking. It should be stated that the cost of felling and bucking should be segregated into two items, "felling" and "bucking", wherever possible.

Cost of Bucking (Hypothetical case)

Labor and Wages:

8 windfall buckers	@	$3.00	$24.00
13 regular "	@	3.00	39.00
One-half head bucker's wages per day			2.50
" " " " helper's wages per day			1.25
" " filer's wages " "			2.50
One-eighth scaler's wages " "			.50
One-eighth foreman's " " "			.75
Total daily bucking cost			$70.50

Average Daily Output, Net Scale.

8 windfall buckers	@ 4,000 feet per day	32,000 feet	
13 regular "	@15,000 " " "	195,000 "	
Total output daily-227,000 "			

Average bucking cost per M feet, $.31.

This statement develops the fact that the cost of equipment, supplies, etc., is not included in the cost of the bucking, the number of men in the organization, and that a portion of the wages of the foreman and scaler are included. Not every bucking cost statement is made up of these items.

Organization of Felling and Bucking Crews.

In the large and well-managed camps the fallers and buckers are directly in charge of a head bucker who does no productive work other than divide the trees into log lengths. Quite often the head bucker has an assistant who does no

productive work. If the fallers and buckers are working under a bonus system a scaler is a part of the crew. As a general thing the head bucker can discharge men, but cannot employ them. There are still a number of camps where the fallers and buckers are directly in charge of the camp foreman. In some camps under-cutters are still employed.

Factors Influencing the Cost of Felling and Bucking.

In estimating the cost of logging the timber in a given tract, it is necessary to estimate the cost of the felling and bucking of the timber. When one considers how much the cost of this step in the logging operation varies in different camps, it is seen that this is a difficult task. The lowest cost the writer knows of amounted to forty-nine cents, based on six months' time; the highest, ninety-three cents, based on one year's time. These costs are for labor only, including the filing.

In a general way the following factors will influence the cost of felling and bucking:

1. Supply of labor, wages, etc.
2. Efficiency of labor and management.
3. Weather conditions.
4. Size of timber, diameter and height.
5. Kind of timber.
6. Density of stand.
7. Per cent of breakage.

8. Per cent of defect.

9. Length of logs cut.

10. Amount of windfalls.

11. Steepness of ground.

12. Irregulabities in ground.

13. Amount of brush.

Supply of Labor, Wages, etc. Efficiency of Labor and Management: The officiency of labor, the distance of the camp from large towns and cities, the perquisites offered labor, etc., and the efficiency of the management, are discussed in another part of this report.

Weather Conditions: From the standpoint of estimating the cost of felling and bucking in a given tract of timber this factor need not be considered. From the standpoint of collecting cost data it should; that is, when the data covers a relatively short period of time. There is no doubt that the output of a set of fallers or a bucker will vary as to the conditions of the weather, also as to the actual time on the job; during parts of the year light conditions make it impossible for the men to get in a 10-hour day. Just how much the writer does not care to say. The cost data where possible and practical should cover the weather conditions.

Size of Timber. It will be pointed out that the size of the timber influences the output. Whether the authority quoted has drawn the line properly would be impossible to say.

Kind of Timber. Density of Stand. Percent of Breakage. Of these three factors the percent of breakage is by far the most important one. It is clear that the output will be less where the percent of bfeakage amounts to 40 per cent than where it amounts to only 3 per cent. There will be more lost time in a light stand than in a dense stand, especially where the ground is brushy and steep. Of course, where the stand is so dense that two or more fellings are necessary, the opposite may be true. The difference in the output because of different species will amount to little except as different species may mean different-sized timber, and different per cents of breakage.

Per Cent of Defect. Defect in timber will reduce the output in the same way as breakage. In a way it is worse, as breakage under some conditions may reduce the cost of bucking, while defect never does. This factor in the cost of felling and bucking is growing more important, and it will continue to grow as utilization in the woods becomes closer. The effect of defect in pushing up the cost of felling and bucking is shown in one of the felling and bucking cost records given later in this circular. An extreme case is the following, based on 96 days' yarding work. The fallers were paid (contract work) for 6,210 M feet, the buckers (contract work) for 4,773 M feet, while the logs hauled scaled 2,498 M feet at the mill.

Length of Logs Cut. For the most part timber on the west side of the Cascades in Oregon and Washington is cut into

logs running from 32 to 40 feet in length. Real large timber is quite often cut into shorter lengths. Then, too, companies cutting for a special trade, or where the company handles its own logs, not infrequently buck the timber into 60, 90 and 120 foot lengths. When this is done, the cost of bucking will be found to be lower than where shorter logs are cut.

Amount of Windfalls. It has been pointed out that to save the timber for breakage, it is necessary to buck the windfalls. As a general thing, the output from this work is little or nothing. So the cost of bucking will vary with the number of windfalls.

Steepness of Ground. Aside from the increased cost in felling, due to the increase in the per cent of breakage, the increase in the cost of felling on steep ground is due mostly to the loss of time on the part of the felling crew in traveling from one tree to another. The cost of the bucking is increased in the same way. Then the cost of bucking on steep ground will be materially increased, because of the increased danger, slow movements, and more undercutting, wedging and propping.

Irregularities in the Ground. Irregularities in the ground will increase the cost of the felling through increasing the per cent of breakage. This factor will increase the cost of bucking through increasing the danger and the amount of wedging, undercutting and propping.

Amount of Brush. Increases the cost of felling and bucking through increasing the difficulty of travel and increasing the amount of swamping necessary.

Ourput and Cost - General.

The writer will not attempt to lay down any rules for the determination of the output of a set of fallers. It would be a difficult task, if not an impossible one, for one of long experience in this particular line. The numerous factors that influence the output and cost have been enumerated. Just what weight to give any one or all of these factors in a given "show" will depend on judgment. A set of theoretical rules could be formulated, but it is thought that they would not stand the test when analyzed in connection with a number of cost statements. It would no doubt be found that the costs are high when the set of rules suggests that they should be low, and vice versa.

A logging superintendent in discussing felling and bucking made the following statement in October, 1910. While the statement does not develop the nature of the "show" it no doubt can be assumed that the author had similar conditions other than the size of the timber in mind. Other cost data here given dealing with felling and bucking suggests that other factors besides the size of the timber influences the output of a set of fallers or a bucker.

"A good set of fallers should average 50 M feet per

day in timber that averages from 5 to 7 M feet to the tree, or 7 to 10 trees; 40 M feet per day in timber that averages 3 to 5 M feet to the tree, or 8 to 13 trees; 30 M feet per day in timber that averages from 1 to 2 M feet to the tree, or 15 to 30 trees; so it is very evident that the size of the timber makes a material difference. It should require from two to three buckers after each set of fallers. If there are very few windfalls and the slopes or ground is fairly regular so that little undercutting is necessary, two will do the work, but if the other condition exists then it will require three buckers to each set of fallers.

"The felling and bucking of timber which averages from 5 to 7 M feet per tree should cost 48 cents per M feet; timber that averages from 3 to 5 M feet per tree, 55 cents per M feet; timber that averages from 1 to 2 M feet per tree, 65 cents per M feet. The above figures should take care of filing, new saws, axes, sledges, and equipment."

This superintendent also made the following interesting statement: "I know a set of fallers who fell 62 trees in six days, the average tree containing 8000 feet of timber or 496,000 feet, or an average of 82,666 feet per day; they were not working for a record, but simply ran into a good bunnch of timber where the chances were good."

This above general statement is interesting. It is also a rather daring statement. It should be stated that it

was made in an address, and that possibly the author did not have in mind that it would ever be considered in connection with appraisal work.

An analysis of a number of cost statements suggests that the output of a set of fallers as a general thing is between 25 and 35 M feet. Only one camp included in these statements was getting 35 M feet to a set of fallers; another camp was getting 32 M feet; most of them were getting around 28 M feet. Buckers seem to be averaging from 10 to 15 M feet. At one camp there were 3 sets of fallers and 4 buckers, exclusive of the head bucker. Ordinarily there are 2 to 3 productive buckers working with a set of fallers. At one camp there is only one bucker working with a set of fallers. The timber, however, is small and whole trees are yarded. At another camp there were 8 sets of fallers and 16 buckers. Quite often 3 buckers work after a set of fallers.

Cost per Thousand Feet.

The following gives the cost per M feet for felling and bucking at several camps in Oregon and Washington.

Cost of Felling and Bucking on the West Foothills of the Cascades in Oregon, 1911.

Topography.

Rather rough, both in major features and in detail. Slopes of from 30 to 70 per cent, not uncommon, though considerable areas of easy general topography.

Timber.

A heavy and pretty even stand of Douglas fir, with a small and varying mixture of hemlock, also a little cedar. The timber is very defective. Judging from the area being logged, out of a gross stand, if all trees were sound, of 80 M feet or more per acre, only about 50 M feet per acre is run through the mill. The logs average about 1400 feet per tree.

Utilization.

For a long time the company pursued the policy of picking out the best trees as indicated by their appearance, and leaving those the foremen or fallers thought were rotten to stand. The timber left standing varied very widely, ranging from an insignificant amount in sound timber to a very large proportion of the stand. Considerable territory was left with an apparent stand of more than 20 M feet per acre. The leaving of so much timber seemed like waste and cleaner cutting was tried out. Some areas were cut over a second time. As a result it was found that the timber resulting from the second cutting was nearly as sound as that from the first. The management now feels that it is impossible to determine the timber that should be taken out without felling practically all of it. In the recent operations everything had been felled, and many logs had been bucked which were worthless. The management stated that the cost of felling and bucking was 25 cents per M feet higher when practically everything is cut

down than it was when a good share of the stand was left as presumably rotten.

Cost.

The labor cost for felling and bucking in the year 1911, when practically everything was felled, was as follows:

Felling - - - - - - - -	$.437
Bucking - - - - - - - -	.499
	$.936

The cost of axes, saws, etc., amounts to $.05.

The total cost of felling and bucking was as follows:

Felling, labor - - - -	$.437
Bucking- - - - - - - - -	.499
Axes, saws, etc. - - - -	.05
Total cost, felling and bucking - -	$.986

The cost of the felling and bucking is based on the mill scale which was close to the lumber output. It takes care of the wages of the filer, scaler and marker. The fallers were paid 15 to 17 cents per M feet for felling less breakage. Buckers were paid 15 to 21 cents per M feet for bucking, whether the logs were sound or not.

Cost of Felling and Bucking on the Flats to the West of the Cascades in Washington.

The following is the average labor cost per M feet for felling and bucking at a camp in Washington, based on a period of six months and an output of 25,000 M feet (selling scale) in 1912.

Topography.

The ground is practically level. Few hummocks, pot holes, or troublesome ravines were encountered. The ground is quite free of brush and down timber.

Timber.

While the timber is relatively small, it is dense, cutting out 85 to 90 M feet per acre. It averages possibly 30 inches breast high, and is of good height. The logs averaged 550 feet, camp scale, ranging between 32 and 40 feet in length.

Average Cost per M Feet - $.42.

Five sets of fallers worked with three "sides", getting down about 35 M feet per set. Approximately 3 buckers worked with a set of fallers, bucking the down timber in advance of felling and bucking the trees as they were felled. The following wages were paid:

Head fallers - - - - -	$3.25 to $5.50	per day
Second " - - - - -	3.00 to $3.25	" "
Buckers - - - - - - -	3.00	" "
Filer - - - - - - - -	3.75	" "

Only one filer was employed. The camp foreman was directly in charge of the felling and bucking, but none of his salary is included in the above cost. The logging costs were so segregated as to make it impossible to give the cost of axes, saws, etc.

The average cost per M feet amounted to $.49.

Cost of Felling and Bucking along the Columbia River in Oregon.

In this statement are given the average felling and bucking costs during the years 1910, 1911 and 1912 at a camp in Oregon.

Topography.

Country is mountainous, rough, and broken up. The slopes in general were quite steep. No rock outcrops or cliffs were encountered. There was an average amount of brush.

Timber.

The timber was large, old-growth fir. It is cutting out about 100 M feet per acre, with 20 to 30 M feet of hemlock left. Practically no fir, cedar, or spruce were left, but the aim of the company was to log no hemlock under 28 inches, D.B.H. The logs averaged about 32 feet in length, and the average log contained 1900 feet.

Labor Cost, 1912.

The cost is based on an output of 38,000 M feet.

Bucking - - - - - - - -	$.382
Felling - - - - - - - -	.168
	$.550

Bucking - Includes wages of the head bucker and his assistant buckers, and one-half of the wages of the saw filer. The wages paid the crew were as follows:

Head bucker - - - - - - - -	$3.75	per day
Buckers - - - - - - - - - -	3.25	" "
Assistant to head bucker-	3.00	" "

The head bucker had charge of the felling and bucking, and marked with the aid of an assistant the log lengths. It has been pointed out that the timber is large, and the country rough, making the work of bucking difficult and hazardous. It is not easy to get the buckers to cut the logs the proper length, and buck them square-off, and the company has found it profitable to use a head bucker and an assistant. The log lengths are measured with a tape. The shortest logs cut were 16 feet, but there were very few under 24 feet. A few 60-ft. logs were cut, and a number of 40-ft. logs. The logs possibly averaged 32 feet in length. During the year the company averaged about 3 sets of fallers and about 16 buckers. This is about 5 buckers to a set of fallers, which seems high, but facts bear it out. In the month the writer visited this camp 10 fallers and 16 buckers were working.

Felling. Includes the wages of the fallers and one-half the wages of the saw filer. The following are the wages paid the fallers:

Head fallers - - - $3.75 per day

Second " - - - 3.40 to $3.50 per day

Labor Cost, 1911.

The cost is based on an output of 26.605 M feet. Average log, 1556 feet.

Felling - - - - - -	$.31 per M feet
Bucking - - - - - -	.46 " " "
	$.77

The management felt that this cost was too high.

Labor Cost, 1910.

The cost is based on an output of 16,721 M feet.

Felling and Bucking - - - - $1.10.

Cost of Felling and Bucking on the Western Foothills of the Cascades in the State of Washington.

In this statement are given the average felling and bucking costs during the years 1911 and 1912 at a camp in western Washington.

Topography.

The ground covered during these two years represents a mixed topography, there being good and bad "shows". Some of the ground was quite level, with a relatively regular surface. Other parts of the ground, while quite level in a general way, were quite badly broken up by small hummocks and pot holes. Slopes from 30 to 60 per cent were not uncommon, their surface varying in smoothness like the level land.

Timber.

Consisted of old and second-growth; at least it could be so classed as to size. It cut out about 50 M feet per acre, about as follows: Cedar, 45%; hemlock, 5%; Douglas fir, 50%. The average length of the logs cut was approximately 36 feet; the average volume, about 1000 feet. The output in 1911 was about 52 million feet; in 1912, about 48 million.

Average Cost per M Feet, 1912.

Labor cost only $.717, including the cost of felling,

bucking, and filing. As a rule, two and one-half to three buckers worked with a set of fallers.

Average Cost per M Feet, 1911.

Labor cost only $.644, including the cost of felling, bucking and filing. This is $.073 less than for 1912, which is possibly due to the fact that the ground was more level, the timber a little larger, and the per cent of cedar not so great.

Cost of Felling and Bucking along the Columbia River in Oregon, 1911 and 1912.

The following is the average labor cost per M feet for felling and bucking at a camp along the Columbia River in Oregon in 1912 and 1911. Discussion unless qualified refers to the work of 1912. It is thought that the "show" was more difficult in 1911 than in 1912. During 1911 a change of logging superintendents was made which may account for some of the differences in the costs.

Topography and Surface.

The country is quite flat and not badly broken up. It possibly, from the standpoint of the ground, is about as good a "show" as could be found in the Pacific Northwest.

Timber.

It is a second-growth forest which is cutting out about 80 M feet per acre, the trees averaging possibly 28 inches D.B.H. Possibly 95% of the stand is Douglas fir, the balance hemlock. Practically no defective timber is

encountered. The logs averaged possibly 60 feet in length.

Labor Cost, 1912.

The cost is based on an output of 38,000 M feet.

Felling - - - - - - - - - -	$.295 per M feet
Bucking - - - - - - - - - -	.227 " " "
	$.522

Felling. This cost includes one-half the wages of the filer. The wages paid the fallers were as follows:

Head fallers - - - - - - -	$3.75 per day
Second " - - - - - - -	3.50 " "

Bucking. This cost includes the wages of head bucker, buckers and one-half the wages of the filer. The head bucker has charge of the felling and bucking, passes on the timber to be felled and bucked, and marks the log lengths. He had charge of about 8 sets of fallers and 16 buckers.

Labor Cost, 1911.

The cost is based on an output of 34,000 M feet.

Felling - - - - - - - - - -	$.298
Bucking - - - - - - - - - -	.308
	$.606

Cost of Felling and Bucking on the West Foothills of the Cascades in Washington.

The following is the average labor cost per M feet for felling and bucking at a camp in the foothills of the Cascades in western Washington. It is based on the output of the

first six months of 1913.

Topography.

Sloping ground, 30 to 50%; broken as to topography and quite smooth as to surface.

Timber.

Second growth; possibly averaging 30 inches D.B.H., and cutting out about 80 M feet per acre. About 4½ 32-ft. logs were cut from the tree. Most logs were cut 32 feet in length.

Cost.

Felling - - - - - - - - -	$.23 per M feet
Bucking - - - - - - - - -	.37 " " "
Total -- - -	$.60 " " "

Cost of Felling and Bucking on the West Slope of the Cascades in Washington.

The following is the average labor cost per M feet for felling and bucking at a camp on the west slope of the Cascades in Washington in 1911.

Topography.

Mixed topography. Good and bad shows. During a part of the year the ground was extremely rough. Breakage amounted to about 15 per cent.

Timber.

The timber consisted of Douglas fir, western red cedar, western hemlock, Sitka spruce, and amabilis fir. The logs, including cedar slabs, contained an average of 1200 feet. Tops were used to a diameter of 10 inches when merchantable and

cedar chunks and slabs down to the size of shingle bolts.

Cost:

Labor cost only $.709 per M feet, including the wages of the filer. Three buckers worked with a set of fallers, one of them working ahead bucking up the windfalls. The fir being heavier was felled first, then the cedar, and lastly the hemlock and amabilis fir. The following are the wages paid:

Head fallers - - - - -	$3.25	per day
Second fallers - - - -	3.00	" "
Buckers- - - - - - - - -	3.00	" "
Filer- - - - - - - - - -	4.00	" "

Cost of Felling and Bucking along the Columbia River in Washington.

The following is the average labor cost per M feet for felling and bucking at a camp along the Columbia River in Washington in 1912. It is based on a year's time, and an output of 19½ million feet.

Topography.

Country is generally flat, but badly broken up by pot holes and small ravines.

Timber.

The stand was practically all hemlock, running not more than 5% to Douglas fir. It cut out about 45 M feet per acre, the trees averaging about 30 inches D.B.H. The tract was brushy. On the average about three 32-ft. logs were cut from

the trees. Average volume per log, 670 feet.

Cost.

Felling - - - - - - - - $.324 per M feet

Bucking - - - - - - - - .400 " " "

Total - - - $.724 " " "

Felling. Labor cost, including one-half the wages of the filer. The following are the wages paid:

Head faller - - - - $3.60 to $3.75 per day

Second faller - - - 3.40 to $3.50 " "

Filer - - - - - - - - 4.00 " "

Bucking. Labor cost, including the wages of the head bucker and one-half the wages of the filer. The head bucker had charge of the felling and bucking crews, and marked where the cuts were to be made. The following are the wages paid:

Head bucker - - - - $4.00 per day

Buckers- - - - - - - - 3.00 to $3.25 per day

Cost of Felling and Bucking along the Columbia River in Oregon.

The following cost statement was not taken from the books of the company, but was based upon the average output:

Average Crew, Wages, and Total Daily Cost:

10 head fallers - - - - - - - -	@	$3.50	$35.00
10 assistant fallers- - - - -	@	3.25	32.50
25 buckers- - - - - - - - - -	@	3.00	75.00
1 filer- - - - - - - - - - -	@	4.00	4.00
1 filer - - - - - - - - - - -	@	3.50	3.50
1 head bucker- - - - - - - -	@	4.00	4.00
1 head bucker- - - - - - - -	@	3.75	3.75
Total cost of 49 men			$157.75

Average Estimated Labor Cost of Felling and Bucking.

The cost per M feet based on an average daily output of 220 M feet amounts to $.71.

"Show".

The timber for the most part is old-growth Douglas fir, and more defective than the average stand. Ground conditions are better than the average.

Utilization.

The fallers are instructed to fell all the timber. Breakage seems to be too large.

Comment on Cost.

A logging superintendent from another camp stated that the felling and bucking cost too much at this camp.

Cost of Felling and Bucking along the Columbia River in Oregon.

Wages. (Winter of 1914)

Buckers - - - - - - - - -	$3.25
Fallers - - - - - - - - -	3.25
Head bucker - - - - - - -	3.50
Filer - - - - - - - - - -	4.00

Organization.

There are two buckers with each set of fallers. The head bucker has complete charge of this work, but is not authorized to hire or discharge any of the crew.

"Show".

Mostly small old-growth Douglas fir, running about 60 M feet to the acre. Ground conditions, average.

- Cost (1913)

Felling and Bucking, per M feet - - - $.80

Labor - - -	$.78
Supplies- -	.02
	$.80

"Supplies" cover the cost of saws, oil, wedges, sledges, axes, files, etc.

Cost (1912)

Felling and Bucking, per M feet - - - $.68

Cost of Felling and Bucking on the West Foothills of the Cascades in Washington, 1912.

Topography -

Steep and rough.

Timber.

Large, old-growth, the defect and breakage amounting to approximately 30%. Cedar breakage is especially bad.

Cost.

A head bucker receiving $125 per month was in charge of the work. The following wages were paid per day: Head fallers, $3.75 to $4.00; second fallers, $3.50; buckers, $3.25; filer, $4.00.

The labor cost per M feet amounted to $.709.

Cost of Felling and Bucking in the Grays Harbor District, 1915.

Topography.

Ground fairly good.

Timber.

Large, old-growth timber, averaging 70 M feet per acre.

Wages per Day.

Head faller	$4.00
Second "	3.75
Buckers	3.50
Filer	4.00
Head bucker	4.00

Comparison of the Cost of Felling and Bucking.

In the following table is given the costs of felling and bucking at several camps in Oregon and Washington. The costs for the most part represent averages for a year or more. The table shows that the cost of this step in a logging operation varies as to the camps, also that it varies in the same camp from year to year. Several of these costs are discussed in this circular in more or less detail.

Cost per M	Period based on	Year	General Location
$.986	1 year	1912	Oregon, west slope of Cascades
.44°	6 months	1912	Washington, flat west of Cascades
.717	1 year	1912	Washington, west foothills of Cascades
.644	1 year	1911	
.55	1 year	1912	Washington, along the Columbia River
.77	1 year	1911	
1.10	1 year	1910	
.52	1 year	1912	Oregon, along the Columbia River
.61	1 year	1911	
.60	6 months	1913	Washington, west slope of Cascades
.72	1 year	1912	Washington, along the Columbia River

Comparison of Felling and Bucking Costs (Cont'd)

Cost per M	Period based on:	Year	General Location
$.709	1 year	1911	Washington, west slope of the Cascades
.58	1 year	1913	Washington, west slope of the Cascades
.72	5 months	1913	Oregon, along the Columbia River
.60	1 year	1911	Grays Harbor country
.69	1 year	1911	West slope of Cascades, in Washington
.41	1 year	1911	West slope of Cascades, in Washington
.67	1 year	1911	West slope of Cascades, in Washington
.67	1 year	1911	West slope of Cascades, in Washington
.68	1 year	1912	West slope of Cascades, in Washington
.80°	1 year	1913	Along Columbia River, in Oregon.
.71	1 year	1913	Along Columbia River, in Oregon.

°Includes the cost of tools, supplies, etc.

Felling and Bucking Equipment, Supplies, etc.

The cost of felling and bucking equipment, supplies, etc., is not large. It is difficult to approximate this cost for the reason that these expenditures, as a general rule, are not segregated but are included in a general item of cost. The cost per M feet is no doubt close to two cents per M feet. How this cost can be approximated is given later.

Felling Equipment, Supplies, etc.

1 felling saw

2 felling axes

2 spring boards

1 set wedges

2 sledge hammers

1 measuring pole, 8½-ft;

Felling Saws:

Length, 6 to 12 ft., generally range from 7½ to 10 ft. - possibly the largest number of saws in use are 8 ft. in length.

Cost: Depends, of course, on the make and grade. The following are the prices for the "Royal Chinook" pattern, Number 513:

6-ft.	$4.80
6½ "	5.40
7 "	6.00
7½ "	6.60
8 "	7.20
8½ "	7.98
9 "	8.70
9½ "	9.48
10 "	10.20

Life of Saws: Difficult to say,- possibly from three to four months - one saw can be used to get from 2,000,000 to 3,300,000 feet.

Saw Handles:

(1) Cost, per dozen - $6.00

(2) Life, possibly two sets of handles per year.

Felling Axes:

Cost: 4½ lbs., per dozen - $10.75

Life: Possibly from four to six months.

Axe Handles (felling)

Cost: about $4.50 per dozen.

Life: two to three handles per year.

Spring Boards.

Cost: Made by the filer. The iron shoes cost $1.25 per set.

Life: Estimated that one iron shoe will last one year.

Wedges.

Weight per set - 30 lbs.

Cost per lb. - 20 cents .

Life - possibly six months.

Sledge Hammers .

Weight - 9 lbs.

Cost - $1.80.

Life - estimated to wear one year.

Sledge Handles.

Cost - about $4.50 per dozen.

Life - one is estimated to last one month.

Bucking Equipment, Supplies, etc.

1 saw

1 axe

1 sledge hammer

1 set wedges

Bucking Saws.

Cost: Varies of course with the make and grade. The prices for the Simond's "Chinook" pattern are about as follows:

6-ft.	$3.20
6½"	3.66
7 "	4.08
7½"	4.50
8 "	4.92

Life of Bucking Saws: Difficult to say,- possibly a little shorter than the felling saw. Some contend that they last a little longer.

Bucking Axes.

Cost, per dozen - $10 to $12.

Life - possibly from three to four months.

Axe Handles, Bucking.

Cost - about $4.50 per dozen.

Life - Three to four handles per year.

Wedges, Bucking.

Weight per set - 16 lbs.

Cost per lb. - 20 cents.

Life - possibly four months.

Sledge Hammers, Bucking.

Weight - 8 lbs.

Cost - $1.60

Life - estimated to last one year.

Handles, Sledges, Bucking.

Cost - about $4.50 per dozen.

Life - one is estimated to wear one month.

Estimated Cost of Felling and Bucking Equipment, Supplies, etc., per M Feet.

Cost based on the following:

(1) One year, ten months working season.

(2) Output of a felling crew, 28 M feet.

(3) Output of a bucker, 14 M feet.

(4) Twenty-four working days to a month.

(5) Total output, 6,720,000 feet.

Equipment, Supplies, etc., for One Year. One Set of Fallers and Two Buckers.

3 felling saws	@ $7.20	$21.60
6 bucking saws	@ 4.50	27.00
4 felling axes	@ 10.75 per dozen	3.60
6 bucking axes	@ 10.00 " "	5.00
2 iron shoes (spring board)		1.25
45 lbs. felling wedges	@ .20	9.00
64 " bucking wedges	@ .20	12.80
2 sledge hammers, felling		3.60
2 " " bucking		3.20
60 handles, axe and sledge	@ $4.50 per dozen	22.50
Oil, supplies, etc.		100.00
		$209.55

Estimated cost per M feet - $.034

Special Felling and Bucking Equipment.

Tree Faller:

A mechanical device manufactured by the Tree Faller & Cutter Company, of Portland, Oregon. It is designed to do away with wedging, in felling timber, save timber from breakage, and increase the efficiency of the fallers. The device has not been on the market for any length of time. Some foremen think that it is an efficient rig; others think it has no place in a logging camp.

Other Machines:

Other machines for the felling and bucking of timber, to be run by gasoline and electricity, have been put on the market. They have proved of little value to date.

Bonus System.

A camp in western Oregon uses a bonus system in connection with the bucking. Buckers, other than windfall buckers, receive a wage of $3.00 per day and a premium of 13 cents per M feet above a standard gross output of 16,500 feet per day. The standard of 16,500 feet includes about 10 per cent of defect so the standard as it relates to sound timber is about 15,000 feet per day.

Before making the standard, a study of bucking was made. The study showed that to get the desired output it was necessary to have twenty-one buckers, eight of whom are bucking

windfalls, with seven sets of fallers. This is an output of 28 M feet of sound material per set of fallers.

Topography.

The country is mountainous, rough and broken up. The slopes in general are quite steep. No rock ourcrops nor cliffs are encountered. There is an average amount of brush.

Timber.

The timber is large old-growth fir. It is cutting out about 100 M feet per acre, with 20 to 30 M feet of hemlock left. Practically no fir, cedar or spruce is left, but the aim of the company is to log no hemlock under 28 inches D.B.H. The logs average about 32 feet in length, and the average log contains 1,900 feet.

Filing.

It is difficult to state how many saws a filer should do in a day. It will vary, of course, with the ability of the filer, the length of the saws, and the character of the country. Looking at it from the angle of an appraiser it may be stated that at least one filer will be needed for every camp. If the camp is a small one the filer can do other work than look after the saws. If it is difficult to decide whether to figure on one or two filers, it may be stated that any error in judgment will not affect the results enough to speak of. To those who have no idea of the amount of work that should be done by a filer, the following may be of interest.

In one camp the filer was doing about 12 saws per day. There were 5 sets of fillers and 20 buckers working. In addition to keeping up the saws used by these men, he looked after the saws used by the firemen on two loading donkeys, the fireman on the chunking-out donkey, the fireman on the power scraper donkey, and the bull cook. The felling saws were 8½ feet long; the bucking saws, 7 feet. The filer received $4.00 per day.

At another camp the filer stated that he was doing on an average of 16 saws per day, that the largest number he ever did was 20. The fallers changed saws every day or every day and one-half; buckers, every two days. Here the timber was relatively small and the country much better than the average.

GROUND YARDING

General.

Under this heading will be discussed the cost of transporting the logs from the stump to the landing, except as the cost is included under the general heading "Roading" or limited later by specific statements. Different methods are used, and the elements of cost vary greatly. There are many different kinds of labor, equipment, tools and supplies used. The cost will probably fluctuate more widely than any other item of the total logging cost, depending as it does on the "show" and the method used.

For the purpose of a proper understanding of this

step in a logging operation as it relates to the region covered by this circular, it will be necessary to indicate how this transportation is accomplished.

Briefly, it is accomplished by machinery, cables, etc., in two ways: (1) with the logs on the ground; (2) with the logs suspended or partly suspended on an overhead cable. While the following discussion relates to ground transportation it is applicable to overhead logging.

The haul from the stump to the landing may be accomplished with one or two, three or more machines working tandem, depending on the "show" and the amount of spur railroad it is practicable to build. It is sometimes called yarding, regardless of the number and type of machines working, where no considerable amount of pole road is necessary. When two or three machines are working, one frequently hears the expression "double-hauling" or "triple-hauling". If one machine is working the logs will be handled direct from the stump to the landing and the operation will be called yarding. When two machines are necessary, the haul from the stump to the first machine, which machine is generally of the yarder type, may be called yarding, and the haul from the yarder or first machine to the landing may be called roading. Under these conditions the machine at the landing may or may not be of the roader type. It should, of course, be of the roader type. Two machines working tandem, as has been pointed out, may be referred

to as double-hauling. A third machine working between the yarder and the roader is generally referred to as a swing donkey. When two machines are working the machine at the landing is sometimes called a swing donkey.

Roading will be discussed under a separate heading. It refers to the transportation of logs by a roader over a pole road when the distance is greater than 1500 feet. This division, of course, is arbitrary. Quite often logs are transported over a dirt road from the yarder to the landing at a distance greater than 1500 feet, and the operation is not called roading in the sense which the word is used under the heading "Roading". Then, too, in swinging logs from a yarder to the landing at a distance less than 1500 feet it is sometimes necessary to build some pole road.

Ground yarding sometimes includes the work of one machine; at other times it includes the work of more than one. Where more than one machine is used, the fact is brought out. Roading or swinging is also discussed briefly under a special heading.

Ground Yarding Cost, General.

This cost may cover the entire cost of transporting the logs from the point at which they are felled to the landing. The elements of cost in this step of a logging operation vary greatly. There are more different kinds of labor, equipment and supplies used than in any other step, and the total

cost will probably fluctuate more widely than any subdivision of the total cost.

The elements of cost per M feet in a general way are as follows:

Labor
Depreciation
Replacements
Maintenance
Supplies
Output

Labor.

The labor may consist of those who are tending the donkey engines and those who are engaged in the hooking up of the logs, seeing them to the landing, etc. The size, efficiency, wages, and to some extent the organization of the crew varies in different camps or in the same camp by "shows" and different parts of the year.

Different foremen have different ideas of the proper size of a crew. Then the size of the crew will vary in the same camp with the character of the show; size of timber, roughness or steepness of the ground, length of haul, amount of down timber, etc. The number of men in different yarding crews is given in another part of this circular.

The efficiency of yarding crews, of course, varies; either because of the potential efficiency of the individuals in the crew or the efficiency of the management. It is not possible to state the wages that different members of the yarding crew should receive as there is no standard scale of wage.

Wages fluctuate by years, seasons of the year, etc.; then, too, some camps pay higher wages than others. Camps at considerable distance from centers of population may pay higher wages than those near the larger towns and cities. The scales of wages paid the yarding crews at several different camps are given in another part of this circular.

Depreciation.

Besides the labor used directly in yarding the logs, it is necessary to purchase certain equipment, make certain improvement, and consume supplies. The equipment includes donkey engines, cables, rigging, blocks and hooks, etc. The donkey represents a fairly permanent asset which with proper care and barring accident will last a long time. It is, however, subject to depreciation as there comes a time when every engine, no matter how well kept up, must be sold for junk, and so a proper yarding cost per M feet should include an item of depreciation for donkey engines.

When temporary improvements are necessary to get the logs to the landing, provision must be made to include their cost in the estimated cost statement. This ordinarily does not appear under the heading "Depreciation". The cost and depreciation of donkey engines and improvements necessary to get the logs to the landing are covered in another part of this circular.

Replacements.

One of the heaviest items of the yarding cost is the

cable cost. As a general thing it is not included under the item yarding cost, but appears as a special item. Where it appears as a special item, it may include not only the cable used in yarding - main, trip, and straw lines - but rigging - chokers, tag and yarding lines - and loading lines.

Occasionally one finds a cost statement that gives the cost of rigging per M feet. The same things are not ordinarily included under this heading. It has been indicated that this heading sometimes includes chokers, tag and yarding lines. These articles wear out and their cost must be included in the estimated cost statement in some manner. The same thing is true of blocks and hooks. The cost of this equipment is generally included under the heading "Supplies". The cost of wire rope, rigging, blocks and hooks will be dealt with in another part of this circular.

Maintenance.

Another important item of cost is the upkeep of equipment - donkey engines, rigging, clocks, hooks, etc. This work will be done by the machine and blacksmith shop, donkey drivers, etc. It will also include the cost of materials and repair parts. This is a difficult charge to arrive at since the cost of labor in machine and blacksmith shop is seldom pro-rated to the different equipment used in the logging operations. This is also true of materials and repair parts. The cost of maintaining the various kinds of equipment will be dealt with in

another part of this circular.

Collecting Yarding Cost Data.

In collecting yarding cost data care must be exercised to determine what items of expense are included under the item "yarding cost", as this general item includes different items in different cost statements. To assume that this item of cost includes the cost of transporting the logs from the points at which they are felled to the landing, including the cost of all necessary improvements would result in misapprehension. Such an item would include the cost of productive and other labor, supplies, tools, materials, etc. To be more specific; it might be considered as including the cost of building landings; installing water systems; moving donkeys; maintenance and depreciation on machines, and other equipment; supplies of all kinds; a part of the compensation of foreman, time keeper, bookkeeper, scaler, etc.; besides the productive labor employed in moving the logs.

Seldom, if ever, does the cost of yarding as indicated by cost statements include all these items of expense. Quite often other items of expense not mentioned above are included. In one case the cost of laying spur railroad track was considered as a yarding expense. Frequently, of course, the statements, by including certain yarding cost expenses as segregated items, indicate to some extent what is not included under the item "yarding cost". For example, the cost of wire

rope which is a part of the yarding cost is generally given under a separate heading.

Then, too, it will be necessary to determine what this step in the operation consists of. It may include the cost of single-hauling alone, an average of single and double-hauling, or an average of single, double and triple-hauling.

Here, again, the discussion is not complete. It is hoped, however, that sufficient has been said to put on his guard any reader who may later attempt to collect yarding cost data.

Factors Influencing the Output of Ground Yarding.

It is obvious that the average output per yarder per yarding day has a great deal to do with the yarding cost per M feet and that it is something that is very difficult to estimate, since it depends on so many factors. Camps using a bonus system in connection with the yarding, which necessitates the fixing of a standard output per yarder per yarding day by months, find it very difficult to estimate the yarding output.

The following list of factors and discussions are not intended to be complete. The aim is to give suggestive matter only.

Factors:

Yarding Direction as It Relates to the Slope of the Ground.

As a general thing the output of a yarder will be greater where logs are moved up-hill than where they are moved

down-hill, assuming, of course, that the ground is steep enough in places to cause the logs to run. Yarding records given in another part of this circular indicate that the output because of this factor will vary from 30 to 50 per cent.

Volume, Diameter and Length of Logs.

Under the same conditions, within certain limitations, the output will be larger where the average volume of the logs is large than where the average volume is small. With a given number of turns per day the output will be considerably larger where the logs are large than where they are small. As a general thing logs of relatively large average volume have relatively larger average diameters than those of small average volume. Logs of large diameter, assuming that the pulling power is ample, will not "hang-up" as often as logs below a certain average diameter, and so the number of "turns" made in a day may be larger with logs of large diameter than with those of small diameters, resulting in a larger output because of the diameter of the logs. It does not always work out this way as a study of yarding records will show. It may happen that the average volume of the logs suggests rather large timber when the fact of the matter is that the relatively large volume is due to unusual lengths rather than relatively large diameters. It has been pointed out that logs below a certain diameter "hang-up" more than logs of a larger diameter, which has the effect of reducing the number of turns and so the output. Then,

too, much time may be lost in getting long logs started toward the landing.

Slope of Ground.

The output will be larger on level ground than on sloping ground. This is particularly true where it is necessary to move the logs down-hill. When the logs are moved up-hill the difference is not so great.

Regularity of the Ground.

Where the ground is broken up by pot-holes, hummocks, small ravines, etc., the output will be much less than where the ground is quite smooth.

Average Yarding Distance.

It is clear that the output will be greatly affected by the length of haul. A discussion of the effect of the length of haul is given in another part of this circular.

Size of Crew and Efficiency of Men.

The number of men in a yarding crew varies. The size varies in the same camp by "shows". Then, too, different foremen have different ideas of the right make-up of a yarding crew, resulting in more or less variation in size by camps. Generally speaking, up to a certain point, the output will be larger with a large crew than with a small one. However, a large output due to a large crew does not necessarily mean the most economical yarding. It is obvious that the output will vary with the relative efficiency of the crew. It sometimes

happens that high efficiency is secured through paying high wages and the resulting extra daily cost has the effect of increasing the yarding cost per M feet.

Machines, Lines, Rigging, Etc.

The output will vary with the type and condition of the equipment, the way it is used, and the length of life expected from it. It is clear that the output will be larger where up-to-date machines of the proper size are used than where old machines of a wrong size are used; that it will be larger when the machines are driven at approximately maximum speed than when they are driven more slowly for the purpose of prolonging their life and reducing maintenance charges; that it will be larger where lines and rigging are generally replaced as soon as wear indicates that they may break rather than lose time through having them break a number of times. From the standpoint of the minimum cost per M feet a nice balance between output, labor cost, actual equipment cost, - maintenance and depreciation - and supply cost, should be maintained. It is unnecessary to state that this balance obtains in few camps.

Ground Yarding Distance.

It has been pointed out that there is a direct relation between the cost of yarding and the cost of transporting the logs by rail from the landing to the dump or mainline carrier. The ideal method in a given case would be to accomplish the two steps at a minimum cost. The yarding cost can

always be reduced by cutting down the yarding distance. To reduce it, however, beyond a certain point will have the effect of increasing the total cost of yarding and railroad hauling, since what is gained through a reduction in the yarding cost will be more than offset by the increased cost of railroad transportation, through an increase in the mileage of spur railroad track, and in some cases an increase in the length of haul.

While it is possible to build railroads most anywhere, it is not always practicable to do so because of the excessive cost of grading, the large investment necessary and the danger and high cost of operating trains on such roads. This suggests that the topography of the country has a great deal to do in fixing the yarding distance. Under similar conditions as they relate to the yarding "show", the yarding distance may be decreased as railroad transportation per M feet decreases.

The average stand per acre affects directly the cost of railroad transportation per M feet. If the average stand per acre is heavy, more miles of spur railroad per section can be economically built than where the stand is light, and so one can figure on shorter yarding distances in heavy stands than in light ones.

Irregularities in the ground, brush, stumps, down timber, etc., that have the effect of decreasing the yarding output, suggest a decrease in the yarding distance.

With the above in mind it is easy to see that the dis-

tance logs are yarded varies in different camps and in different "shows" in the same camp. As a rule the average maximum yarding distance ranges between 600 and 900 feet. At one camp logs were yarded between 400 and 500 feet. At times it is profitable to yard them 1200 feet or even more. If there is any considerable amount of timber to be moved at a distance greater than 1200 feet, it probably will be best to double-haul.

Major Causes of Loss in Actual Yarding Time.

There is of necessity considerable loss of time in actual yarding time. Donkeys have to be moved from one landing to another and from one end of the landing to the other. Then, too, lines have to be changed. These are necessary delays. Loss of time results from other causes. The aim of the camp foreman is to reduce the loss in the first case to the minimum and to eliminate entirely the loss of time in the second. To state that unnecessary delays are ever eliminated would not be in accordance with the facts. Some camps keep a record of lost time. The following is an example.

Camp in Western Washington.

Waiting for trucks - - 40 hours or 4 days
Moving yarders - - - -240 " " 24 "
Changing ends- - - - - 90 " " 9 "

Total loss- - -370 hours or 37 days

Total number of landings - - - - - 27

Average time lost in moving a yarder from one landing to another - - - - - - - - - 8-8/9 hours

Average time lost in changing ends - - - 3-1/3 "

Average amount yarded to a landing - - -830,000 feet

Number of yarding days - - - - - - - - - - 383

Number of productive yarding days, 383 days minus 37 days, or 346 days.

There are, of course, other losses in actual yarding time, such as changing lines, splicing lines, breakdowns, etc.

Moving yarders includes raising jinn poles, setting and putting out lines.

Changing ends includes putting out lines.

Moving Donkeys.

It has been pointed out that there is considerable loss of productive time in yarding due to moving donkeys. The statement enumerating the major causes of loss in actual yarding time indicates that the average time consumed in moving donkeys was about 9 hours, which average time included the raising of jinn poles and putting out lines. The donkeys were moved on flat cars from one landing to another by the yarding crew. The ground was better than the average. One superintendent stated that donkeys can be dragged from one landing to another at an average distance in about 5 hours.

A hooktender in a camp along the Columbia River loaded the yarder, moved to a new landing, set up and put in 54

logs in one day. A hooktender in a camp on the west slope of the Cascades moved a 10x12" donkey over the ground at a distance of 2500 feet in 10 hours with a yarding crew of 11 men. Half the move was made up a grade of 40 per cent. The ground was practically clear of chunks.

Changing Ends.

A hooktender in a camp along the Columbia River changed ends and ran the trip line around a week's logging in 2 hours and 10 minutes. The ground was good.

A hooktender in a camp along the Columbia River changed ends and put out lines in 1 hour and 25 minutes. The ground was good.

A hooktender in a camp along the Columbia River changed ends and yarded 78 M feet the same day, there being about two and one-half hours of dead time.

Output, Ground Yarding.

Under the heading "Factors Influencing the Output of Ground Yarding" it was pointed out that the output per yarder per yarding day has a great deal to do with the yarding cost, and that it is a difficult thing to estimate. The estimation is largely a question of "judgment". Just how one can develop this judgment the writer will not attempt to say. Neither will he attempt to lay down any general rules for estimating the output of ground yarders under different conditions. It would be a difficult task, if not an impossible

one, for one of long experience in this particular line. The numerous factors that influence the output have been indicated. Others will occur to readers. A set of theoretical rules, as in the case of felling and bucking, could be formulated, but it is thought they would not work.

One authority in discussing the output of a yarding crew made the following interesting statement in 1910: "A yarder logging in timber where logs average from 1500 to 2000 feet to the log with 900 feet of line, should average 45 logs per day, or 67,500 to 90,000 feet per day; logs averaging from 1000 to 1500, 50 logs per day or from 50,000 to 75,000 feet per day; logs averaging from 500 to 1000 feet per log, 55 logs or from 27,500 to 55,000 feet per day; on logs averaging less than 500 feet, 65 logs per day or about 30,000 feet. To make the above amounts more definite:

Logs averaging	2000	feet	- - - - -	90,000	per	day		
"	"	1700	"	- - - - -	78,750	"	"	
"	"	1500	"	- - - - -	67,500	"	"	
"	"	1250	"	- - - - -	62,500	"	"	
"	"	1000	"	- - - - -	55,000	"	"	
"	"	750	"	- - - - -	41,250	"	"	
"	"	500	"	- - - - -	32,500	"	"	
"	"	250	"	- - - - -	22,500	"	"	"

The statement points out that the above "amounts were arrived at from time records rather than other methods", and that "proper allowances were made for moving yarders from one setting to another".

It further states that the "calculations were based on the following time: - trip or haulback line, 425 feet per

minute; mainline, 225 feet per minute; or if the yarder is working at an average distance of 450 feet, the actual time the machine is hauling logs per day is about two hours and thirty minutes, which, with the necessary short starts and stops to straighten the logs out of the woods, would make five hours of actual machine work, so that four hours is allowed in these figures for placing of chokers, unfastening of logs by chaser, and pulling windfalls, wood logs, etc., out of the way and changing head block on trip line. One hour being the allowance I make each day for an accumulation of time to move donkey engine when the setting is completed, so that on this basis one hour out of every ten is allowed for moving the yarder to a new setting."

The statement does not develop the character of the ground or whether the estimate was based on up-hill or down-hill yarding. It is obvious that this statement is of questionable value. The writer knows of a number of yearly yarding records that are not in accord with the statement.

Without doubt the best way for anyone not actually in this kind of work to acquire a knowledge of what a ground yarder should do under different conditions would be to visit a number of camps, see the conditions under which the machines were working, and study the yarding records. The only assistance the writer can give will be found in the following records. The number is not considerable for the reason that the number

of camps that make anything like an accurate scale for the purpose of keeping a yearly record by days is not large.

The following gives the output at several camps.

Ground Yarding Output, Columbia River District, 1912.

The following statement is a record of the yarding at a camp in the Columbia River District, during the calendar year 1912, yarding being considered the operation of moving the logs by donkey engines from the stump to roading points. It has no relation to the cost of roading. The fact that about 45 per cent of this timber was double-hauled should be taken into consideration when studying this yarding statement. While it is the aim in double-hauling to so place the roader and yarder that the roader can handle the yarded logs without delay to the yarding crew, such is not always the case. During this year the output of the yarders at times was curtailed by the work of the roaders. Just how much it is impossible to say. There is no question, however, that the yarding record for the year would have been higher if all the logs had been yarded direct from the stump to the rollway.

The average maximum yarding distance was approximately 900 feet. This distance should not be confused with the average maximum distance from the stump to the landing.

Machines.

Size and Type.

No. 1 - - - 10"x13" - - - - geared
No. 2 - - - 11"x13" - - - - "
No. 3 - - - 10"x13" - - - - "

The machines were made by the Willamette Iron and Steel Works of Portland, were new, and for the year, up-to-date. Yarder #1 carried 2000 ft. of 1¼" mainline, 4500 ft. of 5/8" trip line, and 2500 ft. of 3/8" straw line. Yarder #2 carried the same amount and kind of line as yarder #1. Yarder #3 carried 1800 ft. of 1¼" mainline and 3500 ft. of 5/8" trip line. During most of the year oil was burned on the donkeys.

The direction yarded by months and machines, as to up-hill or down-hill, is indicated on the statement.

It should be pointed out that the records do not take into account the time lost in moving donkeys.

Value of Records.

Seldom are yarding records kept as carefully as these, which is one of the reasons they are given in detail.

Character of Country.

The country is mountainous, very rough and badly broken up. The slopes in general are steep. No rock outcrops or cliffs were encountered.

Character and Condition of the Forest.

Principal Species.- Douglas fir; others, hemlock, cedar and spruce.

Stand per Acre. Possibly 100 M feet per acre cut, 20 to 30 M feet of hemlock left.

Size of Timber. The logs averaged about 32 feet in length, and the average scale per log amounted to 1904 feet.

The contents of the average log by species are given in the tables.

Camp Scale Report for Year 1912.

Species	Scale ft. B.M.	No. of Logs	Contents of Avg. Log.
Douglas fir	32,204,222	14,369	2,241
Spruce	829,157	497	1,667
Cedar	2,868,684	2,665	1,076
Hemlock	1,868,065	2,301	819
Totals	37,788,128	19,832	

No. of machine days	531	
Avg. scale per yarding day	151,797	ft.B.M.
" " " yarder per day	71,164	" "
" number of logs per yarder per day	37	
" scale per log	1,904	
No. of cars loaded	5,099	
Avg. scale per car	7,410	
Cull and used logs logged but not included in the above scale	405	

Scale Report, 1912.

	D. Fir Scale	Spruce Scale	Cedar Scale	Hemlock Scale	Total Scale	No. Ydg. Days	Av. Scale per day	No. logs	No. cars	Av. Scale per car	Method of Yarding
Feb.--											
Ydr. #3	542604		50943	1672	515219	11	54110				Down hill
" #1	515653	13002	19040	22198	570701	10	57070				" "
" #2	269637	2066	111510	10179	413392	9	45932				" "
Total	1347894	15068	182301	34049	1497312	30	52643	964	242	6500	
March--											
Ydr. #3	1080872	12538	76044	40480	1209934	20	63626				Down hill
" #2	1280083	4622	44209	70149	1399063	26	53021				" "
" #1	994187	15431	188837	42542	1240997	26	45692				" "
Total	3355142	32591	309090	153171	3849994	72	53458	1964	533	7223	" "
April--											
Ydr. #1	2000528	49050	22278	118957	2190813	26	84262				Up hill
" #2	1255734	27717	132543	37193	1453187	26	55891				Down "
Total	3256262	76767	154821	156150	3644000	52	140015	1803	495	7361	
May--											
Ydr. #1	1809114	76124	226443	91014	2202695	24	91778	1115			Up hill
" #2	891623	130127	341668	36609	1399527	27	51612	839			Down hill
Total	2700737	206251	568111	127623	3536222	51	133267	1954	492	7309	
June--											
Ydr. #1	1642802	13054	168329	151622	1975807	25½	78253	1194			Up hill
" #2	908745	223551	223465	103218	1463979	24½	60370	780			Down hill
Total	2551547	236605	391794	259840	3439786	49½	138981	1974	473	7372	
July--											
Ydr. #1	1310823	12900	122213	69978	1515914	19	79784	768			Up hill
" #2	1395250	40248	68909	98161	1606568	19	83503	798			" "
Total	2098073	53148	191122	168139	3102482	38	163288	1566	429	7231	

Scale Report, 1912.

	D. Fir Scale	Spruce Scale	Cedar Scale	Hemlock Scale	Total Scale	No. Ydg Days	Av. Scale per day	No. logs	No. cars	Av. Scale per car	Method of Yarding
August:											
Ydr. 576	1563362		48196	189809	1801367	26¼	68623	1115			Up hill
" #2	2288492		118103	132456	2539051	26½	96725	1318			" "
Total	3851854		166299	322265	4340418	52½	165348	2433	591	7344	" "
Sept.--											
Ydr. #1	1903080	11481	107835	86003	2108399	24	87849	1087			Up hill
" #2	1816736	24269	140659	94349	2076013	24	86500	1021			" "
Total	3719816	35750	248494	180352	4184412	48	174349	2108	547	7649	" "
Oct.--											
Ydr. #1	2097459	16214	119587	65665	2298925	26	88420	1170			Up hill
" #2	1801588	30606	145243	107956	2085393	26	80207	1051			" "
Total	3899047	46820	264830	173621	4384318	52	168627	2221	553	7928	" "
Nov.--											
Ydr. #1	1221419	14038	163842	73701	1473000	24½	62680	782			Up hill
" #2	1590058	27512	98531	130622	1846723	23½	78583	933			" "
Total	2811477	41550	262373	204323	3319723	47	41264	1715	428	7756	" "
Dec.--											
Ydr. #1	1029944	50594	116912	69242	1266692	19½	64958	648			Up hill
" #2	984429	34013	12537	143290	1174269	19½	60219	562			" "
Total	2014373	84607	129449	212532	2440961	39	125177	1210	316	7724	" "

Yarding Crew. The yarding crew consisted of the following men:

1 Hooktender
4 Rigging men
1 Sniper
1 Chaser
1 Whistle punk
1 Engineer

At times it was necessary to use 5 instead of 4 rigging men, an extra chaser and a bull-block man.

Oil was used as fuel.

Ground Yarding Output, Columbia River District, 1912.

The following is a record of the work done at a camp along the Columbia River in 1912 with three yarders. No logs were double-hauled, and the average maximum yarding distance amounted to about 800 feet. The yarding "shows" from the standpoint of ground were for the most part as good as can be found in this region. Seldom if ever was the ground steep enough to cause the logs to run. Not less than two logs were yarded at a turn; sometimes three or four; and occasionally as many as five. The yarders were up-to-date in design, in good repair, and were driven at practically their highest speed. During a part of the year two of the yarders burned oil.

Yarders Nos. 1 and 2 handled longer logs than yarder No. 3, which was due to the fact that the logs were sold differently. Logs as long as 90 feet were yarded by these yarders, the average length amounting to 60 feet. The logs handled by yarder No. 3 were not cut longer than 40 feet, and averaged about

32 feet.

Character of Forest.

The forest is about 150 years of age, and is cutting out about 80 M feet per acre - the trees averaging about 28 D. B.H. Possibly 95% of the stand is Douglas fir.

The average output per yarder per yarding day was as follows:

Yarder #1	83,677 ft.
" #2	81,696 "
" #3	66,220 "

The average number of logs per yarder per yarding day was as follows:

Yarder #1	118
" #2	113
" #3	140

The volume of the average log by yarders was as follows:

Yarder #1	705
" #2	721
" #3	469

The three yarders were of the same size, make and age; the "shows" from the standpoint of timber, ground and maximum yarding distances were practically the same. The average daily output of yarders #1 and #2 was practically the same, both from the standpoint of the amounts in logs and the amounts in feet. The output from yarder #3 was about 15 M feet less than the daily output from yarder #2, and about 17 M feet less than from yarder #1. While it cannot be said that the difference was entirely due to the difference in the size of the

logs - the other factors, of course, were not exactly the same - it is quite clear that the difference is for the most part due to this fact.

The record of the total scale by yarders is as follows: (The records do not take into account the time lost in moving donkeys.)

Record of Work, 1912, Yarder No. 1, Willamette, 10"x11", Simple.

Month	No. of logs	No. of days	Scale for Month	No. logs per day	Size of Average log	Scale of Logs per day
March	2129	24½	1,839,305	88	864	76,651
April	2514	24½	1,815,921	104	722	75,663
May	3118	26	2,496,409	119	800	95,938
June	2836	24½	2,081,543	118	734	86,730
July	2240	20¼	1,550,160	112	692	77,594
Aug.	3151	25	2,185,965	126	690	87,368
Sept.	3563	24½	2,291,390	148	643	95,458
Oct.	3310	27	2,264,740	122	684	87,352
Nov.	2858	20	1,733,635	141	610	86,700
Dec.	2213	19	1,405,056	116	635	73,950
Average or Total	27912	235½	19664124	118	705	83,677

Timber ran 80 M feet per acre, averaging possibly 28" at the butt. Logs were cut as long as 90 feet. Average length of logs, about 60 feet.

Record of Work, 1912, Yarder No. 2, Willamette, 10"x11", Simple.

Month	No. of logs	No. of days	Scale for Month	No. logs per day	Size of Average log	Scale per day
March	2207	22	1,609,515	100	729	73,135
April	2551	24½	2,051,757	106	580	85,448
May	3015	26	2,320,325	116	770	89,232
June	2741	24½	2,004,187	114	731	83,924
July	2331	20¼	1,641,655	116	708	82,000
August	3550	24½	2,342,992	147	652	97,521
Sept	3252	24½	2,562,796	134	726	98,373
Oct.	2446	25	1,992,242	97	814	79,729
Nov.	2177	24	1,311,833	90	602	54,658
Dec.	1804	16½	1,252,120	112	694	78,259
Totals or Averages	26062	230½	18,739,422	113	721	81,692

Timber ran 80 M feet per acre, averaging possibly 28" at the butt. Logs were cut as long as 90 feet. Average length of logs, about 60 feet.

Record of Work, 1912, Yarder No. 3, Williamette, 10"x11", Simple.

Month	No. of logs	No. of days	Scale for Month	No. logs per day	Size of Average log	Scale per Day
May	2,734	24½	1,117,669	136	430	49,029
June	3,855	24½	1,791,908	160	473	74,662
July	3,165	20	1,358,374	158	427	67,618
August	4,185	23¾	2,102,531	181	502	91,410
Sept.	3,608	27	1,604,916	150	444	66,850
Oct.	3,119	24¼	1,436,379	130	460	59,849
Nov.	2,865	22¼	1,533,861	130	535	67,720
Dec.	1,715	16	849,218	107	495	53,076
Totals or Avgs.	25,246	179	11848857	140	469	66,220

Timber ran about 80 M feet per acre, averaging possibly 28" at the butt. Logs were not cut longer than 40 feet. Average length of logs, about 32 feet.

Record of Total Log Scale, 1912.

Yarder	No. of logs	No. of Machine Days	Total Scale	Av. logs daily	Av. volume logs	Av. daily output ft. B.M.
#1	27912	253½	19,664,124	110	705	83,679
#2	26062	230½	18,789,422	113	721	81,692
#3	25246	179	11,848,857	141	469	66,220
Total	79220	662¾	50,302,403	364	634	231,591

Total No. logs - - - - - - - - - - - - - - 79,220

Av. volume of logs - - - - - - - - - - - - 634 ft. B.M.

Av. length of logs - - - - - - - - - - - - 51 linear feet

Total scale for year - - - - - - - - 50,302,403 ft. B.M.

Av. No. logs daily - - - - - - - - - - - - 119

Av. daily output - - - - - - - - - - - - -231,591 ft. B.M.

Av. daily output per yarder- - - - - - - 77,197 ft. B.M.

Ground Yarding Output, Western Foothills Cascades in Washington, Three Years.

The following is the yarding output for three years at a camp in the western foothills of the Cascades in Washington.

Output, 1912.

The average output per yarder per yarding day in 1912 was 37,500 feet. All timber was yarded direct to landing. Twelve by twelve Washington Iron Works Compound Yarders were employed. Oil was used as fuel. Ground was hilly and practically level; where hilly, the logs were moved downhill. Logs were cut from 24 to 40 feet in length, averaging about 1,000 feet in volume. Forty-five per cent of the timber was cedar, the balance Douglas fir and hemlock. Included in the yarding time is the time consumed in moving donkeys, changing lines, etc. The yarders were used to load the logs.

Yarding Crew, 1912, -

1 Hooktender
1 Rigging slinger

2 Chokermen
1 Whistle punk
1 Sniper
1 Swamper
1 Chaser
1 Bull-block tender
1 Engineer
1 Fireman

Output, 1911.

The average output per yarder per yarding day in 1911 was 45 M feet. The average length of logs was about 36 feet; the average volume, about 1,000 feet.

Output, 1909.

The average output per yarder per yarding day in 1909 was 46M feet. The average length of logs was about 36 feet; the average volume, about 1,000 feet.

Ground Yarding Output, West Foothills Cascades in Washington, Two Years Time.

The following is the average daily yarding output for two years at a camp in the western foothills of the Cascades in Washington.

Country.

Mountainous, badly broken up, slopes steep in places.

Timber.

Logs cut about 32 feet in length on the average and contained about 800 feet B.M. to the log.

Output, 1910.

The output per yarder per yarding day in 1910 was about 40 M feet B.M.

Output, 1911.

The output per yarder per yarding day in 1911 was about 42 M feet B.M. per day.

The average maximum yarding distance was about 800 feet. The time consumed in moving donkeys, changing lines, etc., was included in the yarding time used to arrive at this average.

Ground Yarding Output, Western Foothills Cascades in Washington, 1913.

Country.

Side-hill country, slopes more regular than average.

Timber.

Logs were cut from 30 to 40 feet in length, and averaged about 1,000 feet, B.M. in volume.

Output, 1913.

The average output per yarder per yarding day amounted to about 50 M feet per day.

Logs were yarded an average maximum distance of about 900 feet. Yarding time includes time consumed in moving donkeys, changing lines, etc.

Ground Yarding Output, West Slope of Cascades, Washington, 1912.

The following deals with the yarding output by different kinds of "shows" at a camp on the west slope of the Cascades in Washington in 1912.

Country.

The country is mountainous. The slopes, averaging

about 30° and over, are broken by rock outcrops, slides, sharp gulches, and knolls. Very few places have an even slope for more than 100 feet in any direction.

Timber.

Logs averaged about 32 feet in length and about 1,000 feet in volume.

Output.

When yarding up-hill at an average maximum distance of about 800 feet, the output averaged about 40 M feet per day on timber cutting out about 55 M feet per acre. Down-hill yarding seldom resulted in an average higher than 35 M feet in the same stand of timber.

Machines.

Twelve by twelve compound-geared Washington Iron Works yarders.

Ground Yarding Output Along the Columbia River, 1915.

The average output per yarder per day was about 52,000 feet. It is a two-yarder camp. The logs averaged about 32 feet in length and about 1,000 feet in volume. Time used in moving yarders, changing lines, etc., was included in the yarding time. Country is mountainous and badly broken up. Up-hill and down-hill yarding. Ten by thirteen Willamette yarders are used.

Yarding Crew -

1 Hooktender
2 Rigging men
1 Chaser
1 Sniper

1 Whistle punk
1 Engineer
1 Fireman
1 Woodbuck

Ground Yarding Output, Flat West of the Cascades in Washington, 1912.

The following is the yarding output of a camp on the flat just west of the Cascades in Washington during six months of 1912.

Ground.

Practically level in places, never steep enough to cause the logs to run, quite free of ravines and pot-holes, little brush or down timber. Seldom was it necessary to yard the logs more than 800 feet, the maximum average yarding distance being about 650 feet.

Timber.

Second-growth, dense, fair height, averaging possibly 30" D.B.H. Cutting out possibly 85 to 90 M feet per acre.

Output.

Total output during the year 22,428,120 feet, camp scale. All timber was yarded direct.

Total number of machine days, 383. This includes the time consumed in moving machines - one setting to another - changing ends, raising gin poles, changing lines, as well as yarding logs from the stump to the landing.

Average output per yarder per yarding day, 58,500 feet, camp scale.

Average volume per log, 550 feet.

Size and make of machines, 10½"x10¼" Washington Iron Works yarder. These same machines were used in loading the logs.

Yarding Crew.

The yarding output was made up as follows:

1 Hooktender
1 Rigging slinger
2 Choker men
1 Sniper
1 Knotter
2 Swampers
1 Whistle punk
1 Chaser
1 Donkey engineer
1 Donkey fireman

Ground Yarding Output Columbia River District, 1912.

The following is a record of the yarding at a camp along the Columbia River in 1912.

Topography and Surface.

The "show" from the standpoint of the ground, it is thought, represents about an average one as the country is not particularly rough or badly broken up. The "show", however, from the standpoint of brush, rotten stumps and down timber was a bad one.

Character of Forest.

The stand was practically hemlock, running not more than 5% to Douglas fir. It was cutting out about 45 M feet per acre, the trees averaging about 32 inches D.B.H. On the average three 32' logs were cut from the trees.

Output.

The scale for the year amounted to 19,586,000 feet B.M. The logs were not scaled at the camp, but a record of the output by logs per yarder per yarding day was kept, which is as follows:

Month	No. of Yarding Days: Yarder #1	No. of Yarding Days: Yarder #2	Output Logs: Yarder #1	Output Logs: Yarder #2	Total No. of Logs	Avg. No. Logs Per Day: Yarder #1	Avg. No. Logs Per Day: Yarder #2
April	13½	12	1128	1284	2412	83.5	107.0
May	23½	25	1736	2989	4725	73.8	119.5
June	21	21	1934	2055	3989	92.0	97.8
July	20½	16	1656	1162	2818	80.7	72.6
August	23½	19	1832	902	2734	77.9	47.4
Sept.	24½	18½	2171	1089	3260	88.6	58.8
Oct.	22	26	1594	2494	4088	72.4	95.9
Nov.	14½	17½	1219	1734	2953	84.0	99.0
Dec.	10	15	847	1330	2177	84.7	88.6
Total	173	170	14117	15039	29156	81.6	88.4

Total number of machine days - - - - - - - - 343
Avg. output in logs per machine- - - - - -
per yarding day- - - - - - - - - - - - - - 85
Avg. output in M feet B.M. per machine
per yarding day- - - - - - - - - - - - - - - 57
Avg. volume M feet B.M. per log- - - - - - 670
" stand M feet B.M. per acre, about - - 45
" diameter of trees, inchos, D.B.H. - - 32
" number 32' logs per tree- - - - - - - 3

The yarding time included in the above statement in-oludes break-downs and donkey moves that did not take more

than five hours, so there was really less than 343 machine days during the year. The average maximum yarding distance was about 900 feet.

Yarding Crew.

The yarding crew was about as follows:

1 Hooktender
2 Rigging men
2 Choker setters
1 Whistle punk
1 Swinger
1 Hooker
1 Chaser
1 Bull-block tender
1 Engineer
1 Fireman
1 Woodbuck
1 Branding man

Tandem Hauling.

It is not always practical to yard logs direct to the landing. In a given "show" it may be cheaper to use two, three or more donkeys than to bring the spur railroad sufficiently close to the timber as to make single-hauling at an economical distance possible. Here, as in the length of the single yarding distance, there should be a nice balance in cost between the cost of transporting the logs from the stump to the landing and the cost of spur railroads.

The location of the machines and the distance they are apart will depend on the "show". In a given "show" where the maximum yarding distance is 1500 feet it might be cheaper in the long run to single-haul than to double-haul. If it

were clear that it would be cheaper to double-haul, the machines would be located so that the roader could handle nicely the logs yarded by the first machine. As a general thing the yarder would work at a little less distance than the roader. This, however, is not always the case. Sometimes three machines will be used to get the logs to the landing, and the second machine, due to the ground, will be working but a short distance, say three hundred feet, from the machine at the landing. As a general thing the location of the machines will depend on the topography of the show; the distance they are apart will depend on the same factors that determine the yarding distance. In double-hauling the yarding crew will be the same as when the logs are single-hauled, and the roading crew will consist of an engineer, fireman, wood bucker, chaser and hooker. If the show is bad there may be an additional chaser or two. In some cases no woodbuck, or only one-half a woodbuck, will be charged to this roading crew.

Ground Yarding Cost.

An authority in discussing the total cost of yarding made the following statement in 1910:

Timber	averaging	2000	feet	per	log	- - - - -	$.40	per	M ft.
"	"	1750	"	"	"	- - - - -	.45	"	"
"	"	1500	"	"	"	- - - - -	.53	"	"
"	"	1250	"	"	"	- - - - -	.59	"	"
"	"	1000	"	"	"	- - - - -	.65	"	"
"	"	750	"	"	"	- - - - -	.87	"	"
"	"	500	"	"	"	- - - - -	1.12	"	"
"	"	250	"	"	"	- - - - -	1.60	"	"

Under the heading "Output" is given this authority's estimate of the output for logs of this size where the maximum haul is 900 feet. These yarding cost estimates are based on those output estimates.

The estimate was based on a total daily cost per yarding crew of $36 - labor, $26; upkeep of machinery, blocks, rigging, lines, etc., $10 - the crew being made up as follows: 1 engineer, 1 fireman, ½ bucker, 1 chaser, 1 hooktender, 2 rigging slingers, 1 swamper.

It is clear that this estimate is of questionable value as it relates directly to an appraisal. An analysis of the crew taken in connection with the total daily cost indicates a scale of wages below the average. The cost of the upkeep of machinery, blocks, rigging, lines, etc., is not made to vary as it should be. The total cost is based on an estimated output that is without doubt in error. It is interesting, however, to know how a logger estimates the yarding cost.

The following is the yarding cost at several camps in Washington and Oregon.

Ground Yarding Cost Along the Columbia River.

Cost per M Feet B.M., 1912.

The cost per M feet amounted to $.746.

Discussion of Cost.

Labor cost of transporting the logs from the stump to the landing, including single and double-hauling. The

scalers' wages are included in this heading. It is not possible to give the relative amounts of timber single and double-hauled. The following crew was used:

Hooktender - - - - - - - - -	$5.00	to	$6.00	per	day
Head rigging men - - - - - -	3.75	"	4.25	"	"
3 Assistant rigging men- -	3.00	"	3.50	"	"
Sniper - - - - - - - - - - -	3.00	"	3.25	"	"
Chaser - - - - - - - - - - -	3.00	"	3.25	"	"
Whistle punk - - - - - - - -	2.50			"	"
Engineer - - - - - - - - - -	3.50			"	"

At times it was necessary to use four instead of three rigging men besides the head rigging man, also an extra chaser and a bull-block man. Oil was burned in the machines at the landing.

When double-hauling was in progress it was necessary to use the following additional men:

Engineer - - - - - - - - - -	$3.50	per	day
Fireman- - - - - - - - - - -	2.75	"	"
Woodbuck - - - - - - - - - -	2.50	"	"

At times a further addition of one chaser was necessary.

This cost includes a part of the wages of the following: Foreman, time keeper and bookkeeper. It does not include the cost of moving donkeys from one landing to another, the cost of landings, pole road construction or any depreciation, maintenance or supply charges. The landings cost $.03 per M; pole roads, $.016 per M; moving donkeys, $.044. Depreciation, maintenance and supply charges were not segregated in such a way as to make it possible to determine what they amounted to for yarding.

Timber and Output.

The average scale of logs delivered at landings per yarding day amounted to 71,164 feet. The scale of the average log was 1904 feet.

Ground Yarding Cost Along the Columbia River.

Cost per M Feet B.M., 1912.

The cost per M feet amounted to $.69.

Discussion of Cost.

Labor cost of transporting the logs from the stump to the landing, an average maximum distance of 800 feet. It does not include the cost of moving donkeys from one landing to another, the taking in and putting out of lines when a move is made, the digging of donkey settings, or the raising of gin poles and the slinging of loading rigging. It includes the wages of all men up to the loaders, including the wages of the scaler, all the foreman's salary and one-half the time keeper's salary.

The yarding crew was as follows:

Hooktender	$6.00	per day
Rigging man	4.00	" "
" "	3.50	" "
" "	3.25	" "
Sniper	3.00	" "
Chaser	3.25 to $3.50	per day
Whistle punk	2.50	per day
Bull-block tender	3.25	" "
Fireman	2.75	" "
Wood chopper	2.50	" "
Woodbuck	2.50	" "
Yarding engineer	4.00	" "
Log brander	2.50	" "

During a part of the year oil was burned in two of the three yarders, which reduced the crew of the oil-burning donkeys by three men; fireman, woodbuck and wood chopper. The number and wages of the men, of course, varied some. It is the policy of the camp to use a butt chain block only when a tree roller will not do the work.

Timber and Output.

The average output per yarder per yarding day is as follows:

Yarder	#1 - - - - - - - -	83,677 feet
"	#2 - - - - - - - -	81,696 "
"	#3 - - - - - - - -	66,220 "

The volume of the average log by yarders follows:

Yarder	#1 - - - - - - - -	705 feet
"	#2 - - - - - - - -	721 "
"	#3 - - - - - - - -	469 "

Ground Yarding Cost on Flat West of Cascades in Washington.

Cost per M feet B.M., 1912.

The cost per M feet amounted to $.965.

Discussion of Cost.

Labor cost of yarding, moving donkeys, changing lines, raising gin poles, loading, and laying and lifting track. A gin pole was used in loading, the motive power being furnished by a spool on the yarder. The following is the yarding and loading crew:

1 Hooktender - - - - - - -	$4.50	to	$5.00	per day
1 Rigging slinger- - - - -	4.00	"	4.50	" "
2 Choker men - - - - - - -	3.00	"	3.25	" "
1 Sniper - - - - - - - - -	3.00			" "
1 Knotter- - - - - - - - -	2.75	"	3.00	" "

2 Swampers - - - - - - - - -	$2.75	to	$3.00	per	day
1 Whistle punk - - - - - - -	2.50	"	2.75	"	"
1 Chaser - - - - - - - - - -	3.00	"	3.25	"	"
1 Donkey engineer- - - - -	3.50	"	3.75	"	"
1 Donkey fireman - - - - -	2.50	"	2.75	"	"
1 Donkey woodbuck- - - - -	2.50	"	2.75	"	"
1 Spool tender - - - - - -	3.00	"	3.25	"	"
1 Head loader- - - - - - -	4.00	"	4.50	"	"
1 Second loader- - - - - -	3.00	"	3.25	"	"

The section crew received $2.50 to $2.75 per day.

It was seldom necessary to yard the logs more than 800 feet, the average maximum yarding distance amounting to about 700 feet. The average output per yarder per yarding day was 58,500 feet; average volume per log, 550 feet.

Ground Yarding Cost Along the Columbia River.

Cost per M feet B.M., 1912.

The cost per M feet amounted to $1.189.

Discussion of Cost.

Labor cost of transporting the logs from the stump to the landing. It is not possible to state the average maximum yarding distance. It can, however, be stated that a large per cent of the timber was double-hauled; some of it being triple-hauled. The yarding includes the loss through breakdowns and donkey moves that did not take more than five hours. It does not include the cost of building landings.

The average output per landing per yarding day amounted to 57 M feet, the logs averaging 670 feet.

Ground Yarding Cost. Western Foothills of Cascades in Washington.

Cost per M Feet B.M., 1912.

The cost per M feet amounted to $1.379.

Discussion of Cost.

Labor cost of yarding and loading. All timber was yarded direct to the landing at an average maximum distance of 800 feet. It included the cost of moving donkeys but not the cost of constructing landings. The average output per yarder per yarding day was 37,500 feet. The logs averaged 1,000 feet. The yarding and loading crew was made up as follows:

Hooktender	$5.00	per day
Rigging slinger	3.50	" "
2 Chokermen	3.25	" "
Whistle punk	2.75	" "
Sniper	3.00	" "
Swamper	3.00	" "
Chaser	3.25	" "
Bull-block man	3.25	" "
Engineer	3.75	" "
Fireman	2.50	" "
Spool tender	3.00	" "
Head loader	4.50	" "
Second loader	3.50	" "

Oil was used as fuel in the yarders. The firemen received one-fourth of a day's wages for firing up.

Ground Yarding, Roading and Loading Along the Columbia River.

Cost per M Feet B.M., 1913.

The cost per M feet amounted to $1.73, itemized as follows:

Labor	$1.14
Supplies	.44
Maintenance	.15
Total	$1.73

Discussion of Cost.

This data was not collected by the writer, and it is not possible to discuss it to any extent. It is considered

authentic. The average output was 52,000 feet per yarder per yarding day. It is not known what was included in the yarding time. The logs averaged about 1,000 feet. The yarding crew was made up as follows:

1 Hooktender - - - - - - -	$5.00	per day
2 Rigging rustlers - - -	6.50	" "
1 Chaser - - - - - - - - -	3.25	" "
1 Sniper - - - - - - - - -	2.75	" "
1 Whistle boy- - - - - - -	2.75	" "
1 Engineer - - - - - - - -	3.25	" "
1 Fireman- - - - - - - - -	2.75	" "
1 Woodbuck - - - - - - - -	2.75	" "
9 men- - - - -	$25.50	" "

The loading crew, which also does the scaling, was made up as follows:

1 Loader - - - - - - - - -	$4.00
1 Engineer - - - - - - - -	2.75
2 men- - - - -	$6.75

The engineer bucks and splits the wood and fires the loading donkey.

It is not possible to state the average maximum yarding distance or state the per cent of timber double or triple-hauled.

Ground Logging Engines.

Description.

A fairly complete description of these engines is given in the catalogs gotten out by the manufacturers of these machines. Forest officers in writing for catalogs should not mention the Forest Service, and the request should develop the fact that the writer is not a prospective purchaser.

Make.

Three companies make practically all the ground logging engines used in the states of Oregon and Washington. The following is the name and location of these three companies:

(1) Washington Iron Works, Seattle, Washington.

(2) Willamette Iron and Steel Works, Portland, Oregon.

(3) Puget Sound Iron and Steel Works, Tacoma, Washington.

Size.

The size of yarding engines varies in different camps, due to different "shows" and to different ideas of operators. On the other hand it is not unusual to find a machine of a certain size being used when the operator feels that it is not the proper size. The following gives the sizes of machines used in several different camps:

Camp 1 (Number has no significance)

11x13" Humbolt yarders. The machines were new and the logging superintendent, who is considered one of the most efficient on the Coast, purchased what he considered the most efficient machine for the "show". The machines have the oblong firebox type of boiler.

The country is mountainous, rough and badly broken up. The slopes in general are steep. Logs are moved both up and down-hill - always up-hill when possible. The superintendent desired to have sufficient steam to move all the logs without delay. The logs averaged about 2 M feet in volume. Logs

ranging from 7 to 8 M feet in volume were not uncommon.

Camp 2.

10x11" Humbolt yarders. These machines were new and the logging superintendent, who is considered one of the most efficient on the coast, purchased what he considered the most efficient machine for the "show". The machines have the oblong firebox type of boiler. The ground is for the most part flat. It was never steep enough to cause the logs to run. The logs averaged about 600 feet in volume, but never less than two - sometimes three, occasionally four - logs were hauled at a time.

Camp 3.

10½x10¼" Washington Iron Works yarders.

Timber second-growth, dense, fair height, averaging possibly 30" D.B.H. Logs averaged about 600 feet in volume. Ground, practically level in places; never steep enough to cause the logs to run; quite free of ravines and pot-holes; little brush or down timber.

Camp 4.

One 11x14", five 12x12" compound geared yarding, engines carrying 900 feet of 1¼" mainline and 2000' of ¾" haul-back line.

The timber consisted of Douglas fir, cedar, hemlock, spruce and fir. The logs, including cedar slabs, contained an average of about 1200 feet in volume. Logs ranging from 5 to

7 M feet in volume were not uncommon. Country is mountainous and badly broken. It was considered as a hard "show".

Camp 5.

Five 12x12" Washington Iron Works compound geared yarders.

Ground hilly and practically level; where hilly, the logs were yarded down-hill. Logs cut from 24 to 40 feet in length, averaging about 1100 feet in volume.

Camp 6.

11x13" Humbelt yarders. The logs averaged about 1600 feet in volume. Logs ranging from 6 to 8 M feet in volume are not uncommon. The ground "show" is good.

Camp 7.

12x12" Washington Iron Works compound geared yarders. Camp is on the side of a mountain. The slope of the ground will average over 30° and is broken by rock outcrops, slides, sharp gulches and knolls, very few places having an even slope for over one hundred feet in any direction. Logs were moved both up and down-hill. The logs averaged about 800 feet in volume.

Cost.

"Willamette" Logging Engines, Sept. 1912.

Roaders -

10x11"	60"	boilers - - - - - - - -	$2750.00
10x13"	66"	" - - - - - - - -	3450.00
12x14"	72"	" - - - - - - - -	4350.00
14x14"	76"	" - - - - - - - -	5250.00

Humbolt Yarders -

10x11"	60" boilers - - - - - - - -	$2950.00
10x13"	60" " - - - - - - - -	3300.00
11x13"	66" " - - - - - - - -	3500.00
12x14"	72" " - - - - - - - -	4350.00

The above prices on roaders and yarders include either steam or roller bearing frictions, monkey motion valve gear, manzell force oil pumps, compound grease cups on all bearings, and fair leaders for yarding engines. An extra charge of $150.00 is made for putting loading drums on the roaders. An extra charge of $250.00 is made for putting the oblong boiler on all the above named engines. The quotations are f.o.b. Portland, Oregon.

"Willamette" Yarders f.o.b. Portland, March 1913.

Crackerjack yarder,	10x13" - - - -	$2650.00
Humbolt yarder,	10x11" - - - -	2950.00
" "	11x13" - - - -	3500.00
Express yarder,	12x14" - - - -	4500.00
Mogul "	11x13" - - - -	3650.00
Small yarder,	8½x10" - - - -	1750.00

"Washington" Iron Works (March 1913, f.o.b. Seattle).

Compound geared yarder,	10½x10¼" - - -	$2850.00
" " "	9x10¼" - - - -	2400.00
1913 yarder,	11x11" - - - -	3375.00
" "	12x12" - - - -	3800.00

Weight.

"Willamette" Engines.

Humbolt yarder,	10x11" - - -	30500 pounds
" "	11x13" - - -	37500 "
Mogul yarder,	11x13" - - -	36500 "
Small yarder,	8½x10" - - -	15000 "

"Washington" Yarders.

Compound geared	10½x10¼" - -	29500 pounds
" "	9x10¼" - - -	25000 "
1913 yarder	11x11" - - -	35000 "

Depreciation.

No class of machinery is called upon for such extremely severe service as ground logging engines. The demands upon them are frequently far beyond their normal capacity. In addition it is difficult to give them the attention they should have to keep them in good running order. This results in a relatively short life for this kind of equipment.

It is impossible to give other than the approximate life of a ground yarding engine. This is true for the following reasons:

(1) The machine has undergone many changes. It cannot be said that it has reached perfection at the present time.

(2) There are machines in use at the present time that possibly should be discarded because of obsolescence or because of excessive maintenance charges.

(3) The life of machines is frequently shortened through working them far beyond their normal capacity.

(4) The life of machines is frequently shortened through insufficient maintenance.

(5) The life of machines is frequently prolonged through unprofitable care.

There are yarders working in camps that are 12 or 14 years of age. It may be, however, that it would be profitable to replace them with new machines. Most of the operators the writer talked with placed the life of a donkey engine at eight years. One of the most efficient operators on the

coast figures that it is economical to work his donkeys hard for four years, sell them, and buy new ones. This superintendent possibly works his engines harder than any other operator on the coast. If he can sell these machines at the end of four years for about one-half their original cost, which he hopes to do, it would seem that he figures on a life of about eight years.

Maintenance.

Regardless of the care given ground yarding engines, there will be break-downs through wear, latent defect or accident. It is practically impossible to more than approximate the maintenance cost per year on this class of equipment. There are several reasons why this is true. The upkeep of donkey engines in a general way consists of machine and blacksmith shop work, new parts for engines, and other labor.

Seldom is the total cost of repairs on the donkey engines segregated from the cost of repairs on other equipment, and it possibly is not practical for operators to segregate the repairs on individual donkeys. The factors enumerated as affecting the depreciation on donkeys will also affect the maintenance cost of donkeys.

Total Cost.

The following data was furnished by a logging superintendent, which was taken from a personal record. The figures represent the total cost - labor, repair parts, etc.

In 1911 the repairs on three donkeys amounted to

$1836.00 or $612.00 per donkey. During the year some improvements were made on the machines, which cost is included in the above figures. The machines handled about 27 million feet.

In 1909 the repairs on two donkeys amounted to $432.00 or $216.00 per machine. These two machines handled 18 million feet during the year.

In 1908 the upkeep on one donkey amounted to $682.00. During the year this donkey handled 11 million feet.

In 1910 the repairs on two donkeys amounted to $357 per machine. During the year the two machines handled 21 million feet.

In 1911 the repairs on one donkey amounted to $180. This machine handled 9 million feet.

Repair Parts, Materials, etc.

The repair parts, materials, etc., other than iron and steel bars for three 10½x10½ Washington Iron Works yarders for a period of 6 months in 1912 cost $216 or $73 per machine. This is at the rate of about $150 per machine per year. These machines were about 3 years old. The ground show was good and splendid care was taken of the machines.

The repair parts, materials, etc., other than iron and steel bars for 6 machines for the year 1912 amounted to $1200, which is at the rate of about $200 per machine per year. The machines were about 5 years old. They were worked hard.

Cost of Taking Out Old Flues and Putting New Ones in a Donkey Engine, Including Shop Work.

282 flues cost - - - - - - - -	$279.37
Freight- - - - - - - - - - - -	5.50
5 men for 7 days - - - - - - -	133.65
Total cost - - -	$418.52

Cost of Putting in a Main Drum Shaft.

A 10x15" Tacoma engine broke the main drum shaft and the donkey had to be taken apart and lined over.

Labor cost repairing donkey - - -	$105.37
New shaft - - - - - - - - - - - - -	130.75
Freight and cartage - - - - - - - -	6.38
Total repair cost- - -	$242.50

Donkey Sleds.

For protection and convenience in handling, donkey engines are mounted on well constructed sleds. The more rigid and well secured such a sled is, the more aid it is to the engine in preserving the alignment and durability of parts. Sleds are equipped with heavy rings, chains, bolts, etc., for moving, snubbing, etc. The sleds vary in length, ranging from 30 to 60 feet for yarders and roaders.

The largest sleds the writer has seen are 60 feet long. The wooden parts were as follows: 2 runners, 60'x30"x40"; 4 cross pieces, 8'6"x24"x26"x11"; two cross pieces on which fair leaders rest, 8'6"x36"x40"x11". The master mechanic estimated that the sled contained about a ton of iron. The sled contained about 15 M feet of first-class timber. The runners

were hewed on three sides. The labor cost amounted to $309. The total cost of the sled, including labor, iron and timber, was about $600. The life of the sled was estimated at 3 to 4 years. These sleds were used to accomodate 11x13" and 12x14" machines.

The labor cost of building three sleds, 40 feet long, in 1912 amounted to $612, which is at the rate of $204 per sled.

The total cost of sleds ranges from three to five hundred dollars.

The life of sleds will, of course, vary, depending on the character of the sled, the way donkey moving is accomplished, character of country, and the type of the machine. Possibly it will be safe to figure 3 or 4 years.

Cost of Yarding Equipment for One Machine, Exclusive of Machine, Sled, Fair Leaders, and Tools, etc., on the Machine.

Blocks.

8 side trip blocks	$96.00	
2 head trip "	56.00	
2 yarding "	40.00	
2 moving "	42.00	
2 butt chain "	160.00	
1 extra side for each type of block	30.00	
1 extra yoke " " " "	33.00	
1 extra sheave pin for each type of block	15.00	
Straps	30.00	
Total cost of lines		$502.00

Lines.

1 main line; 1300' in length; 1¼" diam. -	$325.00	
1 trip line; 3500' " " 7/8" " -	455.00	
1 straw line 3500' " " ½" " -	165.00	
1 set splicing tools -	5.00	
Total cost of lines -		$950.00

Rigging.

8 chokers, sockets and hooks - - - - - - -	100.00	
1 20' jerk line- - - - - - - - - - - - -	5.00	
1 40' yarding line - - - - - - - - - - -	10.00	
1 60' " " - - - - - - - - - - - -	15.00	
1 section line - - - - - - - - - - - - -	25.00	
2 swamp hook or grabs- - - - - - - - - -	5.00	
2 butt chains and hook - - - - - - - - -	65.00	
4 cold shuts - - - - - - - - - - - - - -	3.00	
Total cost of rigging -		228.00
Total cost of yarding as per heading -		$1680.00

Note: The above statement does not include rollers or tree spools. If the maximum haul exceeds 1300 feet, the cost of lines will have to be modified.

Fuel.

Three classes of materials are used as fuel on donkey engines, viz., wood, fuel oil and coal. Most operators use wood; a few, oil; possibly a few, coal. The following discussion will be confined for the most part to wood and fuel oil.

Wood.

The following is taken from an address delivered before the Pacific Logging Congress in 1912: ". . . . I had men at the various camps (he was speaking of the camps under his supervision) keep records of the amount of wood used per day by yarders operating in yellow fir and using yellow fir for fuel; yarders operating in red fir and using red fir for fuel;

and yarders operating in silver fir and hemlock and using silver fir and hemlock for fuel; and I found as an average of these tests that we were using for fuel 1650 feet of timber per day per yarder. Of course the contention might be raised that we do not use merchantable timber for fuel, but where you are running the machines for all they are worth this is not so, especially with regard to red fir, silver fir or hemlock. The best logs in the woods are used for fuel. Of course, in the yellow fir you can occasionally get a log that is shattered or full of pitch rings, or a log from a dead standing tree that is worm eaten. Rotten or punky timber will not make steam, nor will a knotty log split. So there you are. It takes good timber to make steam - it makes no difference what kind of timber you are logging. You all know that it costs more to put a wood log behind a yarder than it does to load it on a car and haul it to your mill or any other dumping ground. The hardest men in your camp to keep who render satisfactory service are your fireman and wood buckers; or at least that has been our experience. Figured on the following basis, it costs $18.13 per day to supply steam energy with wood fuel to a logging engine working under ordinary conditions:

Average daily wood consumption, 1650 feet B.M.
Stumpage value of timber , $3.00 per M feet.
Straight logging cost, $4.00 per M feet.
Additional logging cost for wood logs, $.50 per M feet.
One fireman at $3.00 per day.
One wood bucker at $2.75 per day."

The speaker was attempting to show that it was cheaper

in the long run to burn oil than wood. It should be stated that this superintendent works his yarders much harder than the average and no doubt was not able to make sufficient steam with culled logs. The writer cannot give an approximate figure indicating the relative amount of merchantable timber to culled logs used for fuel in logging engines. He knows that some operators working in hard "shows" get along with culled logs.

Oil.

The great argument in favor of burning oil in the woods is the absolute elimination of the fire hazard. Burning oil gives off no sparks and hence the danger always present with coal or wood burning donkey belching forth a cloud of fire-distributing sparks, is done away with. It has been contended, as has been indicated, that in addition to the fire protection it is cheaper to burn fuel oil than wood. On the other hand, there are those that contend that fuel oil is not cheaper than wood, and that it is harder on the flues. As far as the writer knows, the camps now burning oil in their donkeys put the oil in when oil was selling for from 10 to 25 cents per barrel less than it is now. One of the first operators to use oil extensively in his donkeys did not put it in one of his camps because oil f.o.b. that camp would amount to $1.05 per barrel. One authority contends that taking everything into consideration, oil at $1.50 per barrel is a better fuel for

donkeys than wood. As far as the writer knows the effect of fuel oil on the flues of donkeys has not been decided. Those interested in the sale of automatic oil-burning equipment contend that it is the easiest fuel on boilers where the engines are properly equipped.

Oil Records.

The speaker quoted above gave several records of oil consumption which the writer has condensed as follows:

Record No. 1.

Machine, 10x13" Mogul yarder (W. I. & S. W.) 66x120" 200# working pressure boiler, safety valve set at 185 lbs.

Time, five months.

Average daily consumption, 9.6 barrels.

"Show", ground was rough. Average log contained 1975 feet. Maximum yarding distance was 1300 feet; average 650 feet. Average output per yarding day, 80,500 feet.

Cost of oil per barrel delivered in tank on rear end of sled, $1.05, or a fuel cost of $.137 cents per M feet.

Comparison of fuel oil with wood. "Had we used wood fuel this cost would have appeared as $.225 per M feet, or a saving of $.088 per M, or a daily saving of $7.08."

Record No. 2.

Machine, 11x13" Mogul yarder (W. I. & S. W.) 66x120" 200# working pressure boiler, safety valve set at 175 lbs.

Time, five months.

Average daily consumption, 7.8 barrels.

"Show", ground was extremely rough; at times it was necessary to use two lead blocks and a stump roller tc get the timber out at all. The average log contained 1870 feet B.M. The maximum yarding distance was 1500 feet and the average 750 feet. Average output per yarder per yarding day was 59,400 feet.

Cost of oil per barrel delivered in tank on rear end of donkey sled, $1.05; or a fuel cost of $.138 per M feet.

Comparison of fuel oil with wood - "With wood fuel the cost would have been $.305 per M feet or a saving of $.167 per M feet."

Record No. 3.

Machine, 11x13" Mogul tandem drum yarder (W. I. & S. W.), 66x120" 200# working pressure, carrying it full allowable working pressure.

Time - 29¼ days.

Average daily consumption - 8.9 barrels.

"Show" - average daily output, 98,700 feet.

Cost of oil per barrel delivered in tank on rear end of donkey sled, $1.05 per barrel, or a fuel cost of $.089 per M feet.

Comparison of fuel oil with wood - "The wood fuel cost per M feet would have been $.184 per M feet, or a saving of $.089 per M feet.

"In talking over the performance of this machine

with the camp foreman, hooktender and engineer, they were all of the opinion that the oil made it possible for them to get this output. The foreman said 75,000 feet per day would have been all they could have done with wood. The maximum yarding distance was 1200 feet; the average, 600 feet. This was uphill yarding with a maximum lift of 325 feet.

Fuel Oil vs. Wood. (Statement of speaker)

"(1) Conserves the forest.
(2) Reduces the fire risk to a minimum.
(3) Increases the possible output from 15 to 25 per cent.
(4) Reduces the logging cost materially in that it decreases the fuel cost and increases the possible output."

An operator who employs several "Lidgerwood" overhead skidders states that "The cost of oil burned just about equals the cost of labor of cutting and firing the wood used when burning wood as fuel. This means we saved the timber which we formerly had to cut up as fuel, which we estimate at about 1,000 feet per day to each machine, the greater part of which would be merchantable timber."

An operator using three yarders (10½x10¼", 10½x10½" and a 12x12") stated that the machines averaged about 8 barrels (42 gal.) per machine per yarding day. The maximum yarding was about 600 feet. He was yarding about 80 M feet per yarder per yarding day. Another operator who employs five 12x12" W.I.W. yarders stated the fuel oil consumed in his logging engine averaged about 6 barrels per yarder per yarding

day. The machines average about 40 ~~11~~ feet per yarder per yarding day. The average maximum yarding distance is about 900 feet.

The average amount of fuel oil consumed in a yarder per yarding day possibly ranges from 6 to 9 barrels.

Cost of Fuel Oil.

The cost of fuel oil laid down in a camp in Washington in May 1913 is as follows: The oil was purchased from the Standard Oil Company at Seattle for $.75 per barrel of 42 gallons. The freight on a car (80,375 lbs. or 242.23 bbls.) was $80.38. Switching cost, $3.00. The freight and switching charge amounted to $.36 per barrel. The total cost of the oil per barrel laid down at the camp amounted to $1.11.

The company has a three-year contract for oil at $.75 per barrel. At this time (May 16, 1914) fuel oil is selling at $1.00 per barrel f.o.b. Portland or Seattle.

Automatic Vacuum Oil Burner.

The Clafke automatic vacuum oil burner costs about $300. It costs about $25 additional to install.

Transporting Fuel Oil to Donkeys.

The oil is hauled from the storage tank to the tank on the rear of the sled in tank cars. Where the donkey is working along the track an ejector is generally used to force the oil from the tank car to the donkey tank. When the donkey is set away from the railroad the oil is pumped from the tank car to the donkey tank through a 1½" pipe by a small steam pump.

Comparative Fuel Costs - Wood, Coal and Oil.

One operator who has had experience with all three in his donkeys made the following statement: "If you question loggers regarding the cost of wood for fuel the majority of them will tell you that logs used for that purpose have no commercial value. My observation in our camp and in other camps that I have visited, where they are not operating old-growth, defective timber convinces me that wood is more expensive than either coal or oil.

About four years ago while operating in sapling timber, we scaled the logs used for fuel from time to time and found the average to be about 1000 feet per day per donkey; the crew could put these logs on the car quicker than they could put them behind the donkey for the wood cutter. The cost as we figured it is as follows:

Cost of Wood.

Value of logs, 1000 feet on car - -	$8.00
Wood cutters wages- - - - - - - - -	2.75
Total cost per day- - - - - -	$10.75

We then changed our grates and used coal and found the cost per donkey to be as follows:

Cost of Coal.

1½ tons coal @ $4.25, delivered - - $6.28

After using coal about two years we found that while coal had a decided advantage over wood in cost, it did not decrease the fire risk, so we equipped one donkey and one locomotive for burning oil and after trying it out for thirty days

we equipped our entire outfit with oil burners and find the average cost as follows:

Cost of Oil.

Donkey, 6 barrels of oil per day, $1.10 - $6.60.

LOADING

General.

There are a number of ways to load logs, and the cost per M feet varies considerably. This variation in cost is largely due to the output. It will vary to some extent because of the rig used and the wages paid.

In deciding on the method to be used the major consideration is keeping the landing from becoming blocked so that the yarding crew will not lose any time. Of course, in deciding on the method the "show" will have to be taken into consideration.

As a general thing the loading rig consists of a gin pole, a loading line and a crotch line. The loading line passes through a block at the top of the gin pole, then through a purchase block, and thence on to the gin pole where it is fastened as a tail hold. The crotch line is hung to the purchase block. There are some so-called overhead systems used. Two of these overhead rigs are briefly described in the following.

Overhead Loading Rig 1.

The device consists of two guyed trees or gin poles;

one on each side of the track, and anywhere from 200 to 800 feet apart, depending on the "show". Logs can be loaded from both sides of the track at one setting.

A 1-3/8" cable is stretched tight from one tree to another, from 40 to 60 feet from the ground. A carriage rides this line, which can be racked in either direction at a speed of about 800 feet per minute by the two upper drums of a three-drum four-cylinder loading donkey. The lower drum is for the lifting line, which lifting line runs out from the loading donkey to and over the two lower sheaves of the carriage, and then to one of the trees used for the overhead line where it is fastened as a tail hold. The lifting line loops down and a block is hung in the bite of the line which gives the engine a block purchase on the log. A chain bridle with large hooks is fastened to the block. The lifting line is handled entirely independent of the racking lines so that a log can be picked up or lowered while the trolley is being racked across on the overhead line. Any size of log can be picked up and held while the trolley is being racked.

The trolley has a square appearance, consisting of four sheaves, two above and two below.

Advantages of This Rig.

(1) No loss of time because of a blocked-up landing.

(2) The desired log can be loaded.

(3) Wide landing place, 200 or more thousand can be stored at landing, resulting in no loss of time

due to break-downs on railroad.

(4) Long logs can be handled. Logs of a maximum length of 160 feet have been handled. The capacity of the rig is limited only by the capacity of the yarder.

(5) Will handle the output of two yarders, one on each side of the track. More than 100 M feet per day have been loaded with it.

(6) No landings necessary.

(7) Safe.

(8) Inexpensive.

Overhead Loading Rig 2.

The device consists of two wire-guyed gin poles about 60 feet apart. The head pole is about 60 feet tall and is placed on the opposite side of the track from the landing and just far enough from the track to permit the cars to pass. The tail pole is about one-half as tall as the head pole. A two-drum loading engine furnishes the power. The main line passes from the main drum to and through a block at the top of the head tree, then through a purchase block back to the head tree, where it is fastened as a tail hold. So far it is the ordinary crotch line gin pole loading device. A second line passes from the second drum to and through a block at the top of the head tree, then to and through a block at the top of the tail tree, then to the purchase block where it is fastened. An ordinary crotch line with tongs or grabs is hung to the purchase. With this rig the log can be raised

and moved to and from the car.

Advantages of This Rig.

(1) No loss of time because of a blocked-up landing

(2) The desired log can be loaded.

(3) Wide landing place; a hundred or more thousand feet can be stored at the landing, resulting in no loss of time because of a shortage in cars.

(4) No landing is necessary. As a rule a simple landing is used when the output from the yarder is large.

(5) Output large. More than 150 M feet per day can be loaded with this rig.

Power.

The power is furnished by a spool on the yarding donkey or by a loading donkey. The loading donkeys are built with one, two, three or four drums, of the following sizes:

Size.	Weight
7¼x10", 40" boiler - - - - - - - -	14,000 lbs.
8¼x10", 44" " - - - - - - - -	22,000 "
9¼x10", 48" " - - - - - - - -	26,000 "

Cost.

These machines cost from $1500 to $2000.

Output.

The output of course depends on the output of the yarder. With the rigs described above it is possible to take care of the output of a yarder; 50, 75, 100 or 150 M feet may be loaded in a day. The rig and crew must be able to take care of the output of the yarder if the camp is to work at its

greatest efficiency.

Crew and Wages.

If the power is furnished by a spool on the yarder the loading crew is usually considered as being made up as follows:

Crew.

Head loader
Second "
Spool tender

In theory a part of the labor cost of the fireman and woodbuck should be charged to the loading. If the power is furnished by a loading donkey the loading crew will consist of the following:

Crew.

Head loader
Second "
Engineer
Fireman

Wages.

Head loader - - - - - - -	$4.00	to	$5.00	per day
Second " - - - - - - -	3.00	to	$3.75	" "
Spool tender- - - - - - -	3.00	to	3.50	" "
Engineer- - - - - - - - -	3.25	to	3.50	" "
Fireman - - - - - - - - -	2.50	to	2.75	" "

The wages paid the loading crew vary, as has been indicated, in accordance with the usual factors. The chief factor, however, is the output. Where the output is large skilled loaders are necessary, and to seaure them it is necessary to pay the higher scale.

Cost.

The labor cost is the chief cost in loading. It is a simple matter to estimate the daily labor cost for loading. On the other hand it is difficult to estimate the labor cost per M feet as the cost depends on the output as well as the daily cost. An error in estimating the output may result in a relatively large error in the estimated loading cost per M feet. To illustrate: The cost per M feet will be about 100 per cent higher when the output is 50 M feet per day than when it is 100 M feet per day. Of course, taking these two outputs, it will be less than 100 per cent higher as the wages paid would be a little less and one man less might be employed.

The cost of lines, blocks, hooks, etc., has been discussed under separate heading. If the power is furnished by a spool on the yarding engine no machine depreciation would ordinarily be charged against loading. If a loading donkey is used, the total cost of loading would include depreciation on the machine. The life of loading donkeys is probably a little longer than yarding or roading donkeys.

Comparison of the Labor Cost of Loading per M Feet by Camps.

Camp	Period of Time Based on	Year	Cost per M	Location
1	1 year	1912	$.217	Along the Columbia in Oregon
2	1 year	1912	.112	Along the Columbia in Washington
	1 "	1911	.152	
3	1 year	1912	.247	Along the Columbia in Washington

Discussion of the Labor Cost of Loading per M feet Given in Tabulation.

Camp 1. Productive labor cost per M feet for loading logs from landing to trucks. It does not include the cost of building landings, raising gin poles, etc. The following is the crew and wages paid:

Engineer - - - - - - - -	$3.50	per day
Fireman- - - - - - - - -	2.50	" "
Head loader- - - - - - -	5.00	" "
Second loader- - - - - -	3.75	" "

The average output per loading day was about 67 M feet. The power was furnished by a loading donkey. The loading device used made it possible to not only lift the log but to move it to or from the trucks. The logs averaged about 600 feet in volume.

Camp 2, 1912. Productive labor cost per M feet for loading logs from landing to trucks. It does not include the cost of building landings, raising gin poles, etc. The following is the crew and wages paid:

Engineer - - - - - - - - -	$3.25 per day
Fireman- - - - - - - - -	2.75 " "
Head loader- - - - - - -	3.75 " "
Second loader- - - - - -	3.50 to $3.25 per day

The average output per loading day was about 71 M feet, the logs averaging about 1,900 feet in volume. During part of the year oil was used on the loading donkey and no fireman was necessary. Then, too, at times the chaser served as a chaser and second loader.

A gin pole, crotch line and grabs and a double drum Willamette loading engine was used. At times, when the logs contained 6, 7, or 8 M feet, it was necessary to use slings instead of grabs to save the timber; and, to lift these large logs, to transfer the tail hold from the base of the gin pole to the crotch line. As a general thing the logs did not exceed 40 feet in length, and most of them ran about 32 feet in length.

Camp 3. Productive labor cost per M feet for loading logs from landing to trucks, including the cost of moving the loaders. The following is the crew and wages paid:

Head loader - - - - - - -	$4.00 per day
Second " - - - - - - -	3.50 " "
Loading engineer- - - -	3.25 " "
Fireman - - - - - - - - -	2.75 " "

The average output per loading day was about 57 M feet; average volume of log, 600 M feet; average length of logs, about 36 feet; 8½x10" double-drum Willamette loading engines were used.

Collecting Loading Cost Data.

Loading is not always included in logging cost statements as a separate item. Quite often it is included with the cost of yarding. Not infrequently it is included in the cost of operating the trains on the spur railroad.

Landings.

As a general thing the cost of landings per M feet is not included in logging cost statements as a special item of cost. Where their cost is not included as a special item, it is generally included in the cost of yarding or loading. If the cost of yarding and loading is included as one item, it is clear that the cost of landings should be included under this heading unless their cost is included under a special heading. Landings assist both in the yarding and loading of logs, and so their cost could be included in either the yarding or loading cost. Since the landings help more in the loading than the yarding of logs, it probably would be best to include their cost under loading.

In collecting cost data dealing with the construction of landings, care should be exercised to determine what is included in the cost. The cost may include only the labor cost, then it may include the labor, material and supply cost and a rental on machines and other equipment. It may include the cost of the landing proper, the raising of gin poles, swinging

of rigging on gin poles, a part or all of the extended water system, and digging donkey settings. These costs are handled differently by different companies.

Cost of Landings.

The cost of landings varies with the type and the character of the country they are constructed in. The labor cost probably ranges between $50 and $300, most of them being built at a labor cost of from $100 to $150. In the following pages the average costs of constructing landings at several camps are given. It has not been deemed advisable to attempt to describe these landings.

Cost of Landings Along the Columbia River.

The average cost of building 29 landings at a camp along the Columbia in 1912 amounted to $155.00. This includes the labor cost of clearing site, building, raising gin poles, slinging loading rigging on gin poles and digging donkey settings; including, in fact, everything except the moving and setting of donkeys. The country was practically level. This type of landing can be briefly described as consisting of three parts, as follows, starting from the sour track: (1) brow skids; (2) ground for a distance of 30 or 40 feet; (3) jump skids. The logs handled averaged about 800 feet.

Cost of Landings on the Western Foothills of the Cascades in Washington.

The cost of building 75 landings at a camp in the foothills of the Cascades in Washington in 1912 amounted to

about $100. They were of the deck type. The logs handled averaged about 1,000 feet in volume. A gasoline donkey was used in their construction. The cost of the gasoline used in their construction amounted to $370. The value of the logs used in these structures is not included in the above average cost.

Cost of Building Landings Along the Columbia River.

The average cost of building eight landings at a camp along the Columbia River in 1912 amounted to $208. This is the labor cost only, including the clearing of site, building, digging donkey settings, raising gin poles and slinging loading rigging on the gin poles. These landings were not all of the same general type. On the side hills deck landings were used; on the level ground the landings consisted, in a way, of three parts, as follows, starting from the track: (1) brow skid; (2) ground for a space of 30 or 40 feet; (3) the jump skids.

Cost of Building Landings Along the Columbia River.

The cost of building parbuckle or deck landings on side hill country at a camp along the Columbia River amounted to from $285 to $340 in 1912. This does not include the value of the logs in the structure. The following crew was used:

Hook tender - - - - - - - -	$4.50	per day
2 Rigging rustlers- - - -	6.50	" "
1 " " - - - -	3.00	" "
Engineer- - - - - - - - -	3.25	" "
Fireman - - - - - - - - -	2.75	" "
Total per day- -	$20.00	

The fireman bucked his own wood. This crew also does all the chunking, power scrape work, etc.

The logs handled over these landings averaged 1,000 feet.

Cost of Building Landings Along the Columbia River.

The average cost of building eight deck landings in 1912 was $135. This cost includes the labor for clearing site, building landing, raising gin poles, digging settings, putting rigging on gin poles, including in fact everything except the moving and setting of donkeys. The logs handled over these landings averaged 1,800 feet. The average cost does not include the value of the logs in the structures.

Cost of Building Landings on the Flat West of the Cascades in Washington.

The cost of building landings at a camp on the flat to the west of the Cascades in Washington in 1912 ranged from $50 to $70. This is the labor cost only. The landings were of the four-skid-deck type, and were built on practically level land.

Cost of Landings on the West Slope of the Cascades in Washington.

The average cost of building 14 landings on side hill country at a camp on the west slope of the Cascades in Washington in 1912 was as follows: Six on the lower side of the track were built for an average labor cost of $175; eight on the upper side of the track were built for an average labor cost of $95. There were on the average about 7,500 feet of timber in those

on the upper side and an average of about 3,500 feet in those on the lower. They were of the deck type.

Number and Location of Landings.

The number and location of landings will depend on the character of the country. They will, of course, be located along the spur railroads, and as the mileage of spur railroads per section increases, the number of landings per section will increase. The distance that the landings on one side of a railroad track should be apart will depend on the "show" and what the foreman thinks is right. At one camp where the ground was practically level the landings on one side of the spur track were about 850 feet apart; at another where conditions were much the same they were not more than 600 feet apart. Possibly as a general thing they are about 1,000 feet apart. It would seem that they should never be farther apart than 1,800 feet.

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Deacidified using the Bookkeeper process.
Neutralizing agent: Magnesium Oxide
Treatment Date: Nov. 2012

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